263

National Cooperative Highway Research Program

PB99-143562

NCHRP Synthesis 263

State DOT Management Techniques for Materials and Construction Acceptance

A Synthesis of Highway Practice

Transportation Research Board
National Research Council

National Cooperative Highway Research Program

PB99-143562

Synthesis of Highway Practice 263

State DOT Management Techniques for Materials and Construction Acceptance

GARY R. SMITH, Ph.D., P.E.
Iowa State University

Topic Panel

WILLIAM G. DOWD, *Federal Highway Administration*
AHMED FAROUKI, *NICET, Alexandria, Virginia*
ERIC E. HARM, *Illinois Department of Transportation*
FREDERICK D. HEJL, *Transportation Research Board*
PAUL E. KRUGLER, *Texas Department of Transportation*
JOSEPH MERLO, *New Jersey Department of Transportation*
TERRY M. MITCHELL, *Federal Highway Administration*
TOM NELSON, *Washington State Department of Transportation*
JACK E. STEPHENS, *University of Connecticut*

Transportation Research Board
National Research Council

Research Sponsored by the American Association of State Highway and Transportation Officials in Cooperation with the Federal Highway Administration

NATIONAL ACADEMY PRESS
Washington, D.C. 1998

Subject Areas
Planning and Administration,
Materials and Construction

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communication and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to the National Research Council is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and the Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

NOTE: The Transportation Research Board, the National Research Council, the Federal Highway Administration, the American Association of State Highway and Transportation Officials, and the individual states participating in the National Cooperative Highway Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

NCHRP SYNTHESIS 263

Project 20-5 FY 1996 (Topic 27-05)
ISSN 0547-5570
ISBN 0-309-06817-7
Library of Congress Catalog Card No. 98-67631

NOTICE

The project that is the subject of this report was a part of the National Cooperative Highway Research Program conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council. Such approval reflects the Governing Board's judgment that the program concerned is of national importance and appropriate with respect to both the purposes and resources of the National Research Council.

The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, the American Association of State Highway and Transportation Officials, or the Federal Highway Administration of the U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical committee according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the Federal Government. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine. The National Academy of Engineering and the Institute of Medicine were established in 1964 and 1970, respectively, under the charter of the National Academy of Sciences.

The Transportation Research Board evolved in 1974 from the Highway Research Board, which was established in 1920. The TRB incorporates all former HRB activities and also performs additional functions under a broader scope involving all modes of transportation and the interactions of transportation with society.

Published reports of the

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

are available from:

Transportation Research Board
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

and can be ordered through the Internet at:

http://www.nas.edu/trb/index.html

Printed in the United States of America

PREFACE

A vast storehouse of information exists on nearly every subject of concern to highway administrators and engineers. Much of this information has resulted from both research and the successful application of solutions to the problems faced by practitioners in their daily work. Because previously there has been no systematic means for compiling such useful information and making it available to the entire community, the American Association of State Highway and Transportation Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Transportation Research Board to undertake a continuing project to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series reports on various practices, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems. The extent to which these reports are useful will be tempered by the user's knowledge and experience in the particular problem area.

FOREWORD

By Staff
Transportation Research Board

This synthesis will be of interest to state DOT materials and construction engineers; contract, procedure, and specification specialists; construction personnel managers; researchers; and private consultants. The synthesis describes the current state of the practice of state DOT management techniques for materials and construction acceptance, including approaches to inspection and testing. The associated requirements for maintaining adequate qualified personnel to operate the acceptance and testing programs are considered in the information reported. The information was collected by surveying state DOTs and by conducting a literature search.

Administrators, engineers, and researchers are continually faced with highway problems on which much information exists, either in the form of reports or in terms of undocumented experience and practice. Unfortunately, this information often is scattered and unevaluated and, as a consequence, in seeking solutions, full information on what has been learned about a problem frequently is not assembled. Costly research findings may go unused, valuable experience may be overlooked, and full consideration may not be given to available practices for solving or alleviating the problem. In an effort to correct this situation, a continuing NCHRP project, carried out by the Transportation Research Board as the research agency, has the objective of reporting on common highway problems and synthesizing available information. The synthesis reports from this endeavor constitute an NCHRP publication series in which various forms of relevant information are assembled into single, concise documents pertaining to specific highway problems or sets of closely related problems.

This report of the Transportation Research Board presents background information on the changing role of specifications, quality assurance processes, warranties, material certifications, and personnel management regarding the state of the practice for state DOT management techniques for materials and construction acceptance. In addition, detailed information is presented on personnel issues. The details of materials test methods and statistical quality control procedures are not included in the report. However, discussion of these technical aspects of materials and construction acceptance are included on the basis of their influence on personnel training requirements, and changes in administrative requirements.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from numerous sources, including a large number of state highway and transportation departments. A topic panel of experts in the subject area was established to guide the research in organizing and evaluating the collected data, and to review the final synthesis report.

This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now at hand.

CONTENTS

1 SUMMARY

3 CHAPTER ONE INTRODUCTION
Background, 3
Purpose of the Synthesis, 3
Scope, 4
Need for Updated Quality Management Information, 4
General Survey Information, 4
Organization of the Synthesis, 4

5 CHAPTER TWO BACKGROUND
Important Developments, 5
Changing Role of Specifications, 6
Quality Assurance Processes, 8
Warranties, 8
Material Certifications, 8
Personnel Management and Quality Assurance, 9
Federal Highway Administration, 11
Background Summary, 11

12 CHAPTER THREE CONTRACT PRACTICES AND REGULATIONS
Regulatory Issues, 12
Contract Practices, 12
Summary of Contract Practices, 18

19 CHAPTER FOUR MANAGEMENT OF TECHNOLOGY
Laboratory Accreditation, 19
Testing, 19
Certifications, 21
Qualified Products, 22
Technology Change, 23
Summary of Management of Technology Changes, 23

25 CHAPTER FIVE MANAGEMENT AND PERSONNEL ISSUES
Acceptance Programs, 25
Personnel Qualifications, 26
Forecasting Personnel Needs, 27
Summary of Management and Personnel Issues, 27

28 CHAPTER SIX CONCLUSIONS

30 REFERENCES

31 APPENDIX A 23 CRF 637

38 APPENDIX B SURVEY

43 APPENDIX C FAA QUALITY CONTROL PROGRAMS

47 APPENDIX D WISCONSIN WARRANTY PROGRAM

48 APPENDIX E AASHTO ACCREDITATION

50 APPENDIX F SAMPLE OF UTAH QUALIFIED PRODUCTS LIST

ACKNOWLEDGMENTS

Gary R. Smith, Ph.D., P.E., Iowa State University, was responsible for collection of the data and preparation of the report.

Valuable assistance in the preparation of this synthesis was provided by the Topic Panel, consisting of William G. Dowd, Highway Engineer, Highway Operations, Federal Highway Administration; Ahmed Farouki, Senior Civil Engineer, NICET, Alexandria, Virginia; Eric E. Harm, Engineer of Physical Research, Illinois DOT, Bureau Materials & Physical Research; Frederick D. Hejl, Engineer of Materials and Construction, Transportation Research Board; Paul E. Krugler, Director of Technical Operations, Texas DOT, Materials & Test Division; Joseph Merlo, Regional Materials Engineer, New Jersey Department of Transportation; Terry M. Mitchell, Research Materials Engineer, Federal Highway Administration; Tom Nelson, Chief Construction Engineer, Washington State DOT; and Jack E. Stephens, Professor Emeritus, Director CAP Lab, University of Connecticut.

This study was managed by Stephen F. Maher, P.E., Senior Program Officer, who worked with the consultant, the Topic Panel, and the Project 20-5 Committee in the development and review of the report. Assistance in Topic Panel selection and project scope development was provided by Sally D. Liff, Senior Program Officer. Linda S. Mason was responsible for editing and production.

Crawford F. Jencks, Manager, National Cooperative Highway Research Program, assisted the NCHRP 20-5 staff and the Topic Panel.

Information on current practice was provided by many highway and transportation agencies. Their cooperation and assistance are appreciated.

STATE DOT MANAGEMENT TECHNIQUES FOR MATERIALS AND CONSTRUCTION ACCEPTANCE

SUMMARY

This synthesis describes current management practices with regard to the vast subject area of materials and construction acceptance. The background information for the report was developed from a review of the literature on management practices. Other than recent reports on test procedures and new specifications, little information in the literature specifically addresses issues that influence the management methods used in materials and construction acceptance. Therefore, the majority of the current management techniques included in the report were collected using a survey and direct contact with knowledgeable sources within the state departments of transportation (DOTs). As an archival record of DOT practices, this report provides a snapshot of management processes that are evolving.

The management elements examined in the background review are specification techniques, warranties, staffing and personnel requirements, and the new Federal Highway Administration (FHWA) quality assurance regulations for the Federal-aid system. The DOT specifications are gradually changing from method specifications to performance-based specifications. The type of specification used on a project has direct influence on DOT acceptance practices.

Another area of change involves construction warranties, which are creating new opportunities to reduce direct DOT participation in quality control; however, because of various administrative constraints, they have not yet been widely implemented. Previous studies on staffing needs suggested that not many DOTs were using personnel forecasting techniques. Instead, consulting engineers were reported to supplement DOT personnel for inspection testing when resources were limited. While most of the elements discussed in the literature are still valid today, the present status of the DOTs is needed to provide insight into current issues and practices.

The survey conducted for this synthesis examined the management practices in materials and construction acceptance. The impact of new FHWA quality assurance requirements, warranties, certifications, and personnel issues were subjects included in the survey. It appears that innovative contracting procedures, new testing methods, and improved construction and material specifications have improved the ability of DOTs to provide quality control and assurance. In addition to changes in the procedures that DOTs use to monitor and enforce construction specifications, certifications, warranties, and revised staffing arrangements have been used to improve process management.

A major concern while initiating the study was the possible existence of regulatory barriers that would prevent DOTs from using the new FHWA quality assurance requirements; however, no problems were reported. This does not suggest that everyone will implement the nonmandatory portions of the regulation. However, DOT laboratories have rapidly complied with American Association of State Highway and Transportation Officials (AASHTO) laboratory certification processes mandated in the FHWA regulation.

The survey also found that warranties for highway construction were not widely implemented. Where they were, however, the DOT eliminated most testing for the work covered

by the warranty. Due to inexperience with warranties, some tests were conducted to evaluate the materials and provide comparison with the contractor test data. The warranties used were specific to pavement construction and did not include other work on the project. Thus, testing and inspection requirements on all other construction elements remained the same.

The use of consultants to perform inspection and testing was predominantly attributed to a lack of qualified personnel in the DOTs. The qualifications and training requirements for personnel performing tests are virtually the same for DOTs, consultants, and more recently, for contractors. Personnel reductions and changes in technology create conflicting demands for DOTs. Multiple sources of technology training were identified at the national level. Many DOTs are supplementing national program certifications with in-house training or in collaboration with local educational institutions. Few DOTs use personnel tracking or forecasting systems that would enable them to predict future staffing needs or training requirements.

Changes in the materials and construction acceptance specification requirements were explored using the survey. It was found that the use of quality incentive and disincentive pay adjustments was common in DOT specifications. Most DOTs use a certification process for acceptance of a wide variety of materials. Other than natural site materials, certifications can be used for most everything on a project. Some DOTs vary the type of certification required, based on the materials. The level of a certification determines the amount of DOT intervention in the supplier or vendor's process for audits and testing. Qualified product lists were also commonly used. New product evaluations, traditionally evaluated by each DOT, can be evaluated by a national cooperative testing agreement.

The following suggestions for additional study and research were made, based on the assumption that DOT staffing levels were not likely to improve:

- The use of warranties could be expanded to include more construction elements. Warranty time periods would need to be evaluated for effectiveness.
- Certification processes need better definition and more consistency. Reciprocity among DOT certifications is not possible until they are better defined.
- Quality-based qualification could be used for design firms, testing and inspection consultants, and contractors.

CHAPTER ONE

INTRODUCTION

State departments of transportation (DOTs) and similar transportation agencies must deal with the dilemma of reducing their workforces to meet a variety of budget constraints as their workloads related to materials testing, construction inspections, and acceptance program administration increase. A variety of techniques, technological and administrative, have been introduced to meet the demands of the changing environment. These changes permit the DOTs to retain control of materials and construction acceptance decisions under varying management conditions.

This synthesis was initiated to describe the management techniques and approaches to inspection and testing of materials and construction. The broad subject area of management techniques for materials and construction acceptance was considered under three areas: contract practices, management practices, and personnel issues. Contract practices include regulatory changes, warranties, and specification practices. Management practices include laboratory accreditation, testing practices, certifications, and new technology influences. Personnel issues include acceptance program implementation issues, personnel qualifications, and forecasting personnel needs. The various strategies, advantages, and disadvantages of the techniques will be highlighted. The review of current DOT practices will assist decisionmakers in the formulation of future materials and construction acceptance processes.

BACKGROUND

Transportation agencies have made major changes to the systems used to monitor and enforce materials and construction acceptance. Traditionally, a DOT was responsible for performing inspections, conducting quality control tests, and making related acceptance decisions. Today, many agencies use the services of consultants or construction contractors for inspection and testing on projects. This shift in project oversight creates new opportunities and problems in quality assurance practices, contract relationships, and staffing needs.

The evolving process is reflected in the recent change to Title 23, Part 637, Code of Federal Regulations (23 CFR 637), the Federal Highway Administration's *Quality Assurance Procedures for Construction* (*1*). The full text and commentary on the final ruling is provided in Appendix A. The regulation opens new avenues for innovative materials and construction acceptance procedures. The regulation enables transportation agencies to incorporate contractor test data into their quality acceptance procedures, and specifies laboratory certification requirements and personnel qualifications. This suggests that some responsibilities and relationships will shift. The DOT retains the overall responsibility for acceptance. Consultants, once hired only for professional design services, already provide a variety of site engineering and inspection functions including verification sampling and testing programs. Once the focus of inspection by DOTs, contractors will be performing the inspections and providing testing services. They will need to examine their capabilities to provide inspection and quality control testing.

Reduced staffing levels and gradual erosion of expertise within the DOTs have been suggested factors influencing the change. However, the basic relationships among the parties are changing from other influences as well. Innovative contracting techniques, like partnering and design-build, are recent changes to the contract delivery process. The responsibilities of all parties have broadened with the increased emphasis on quality-based infrastructure construction. Contractors, design consultants, and state agencies are now required to perform broad-scope quality assurance activities. Tuggle (*2*) embraces quality assurance by defining a concept called "Construction Quality Management (QM)":

> Today there is an even broader view of the subject of quality assurance. "Construction QM" is a broader term for the overall process of ensuring construction quality products. It not only encompasses contractor process control and owner acceptance issues, including statistical quality control, but also such items as personnel qualifications, training, and certification programs; information management systems such as material control systems; performance-related specifications; innovative contracting practices to achieve quality; incentive-disincentive provisions to encourage quality attainment commensurate with the value received; performance recognition systems for quality projects and personnel; improved materials, tests, and equipment; and quality improvement techniques for both external and internal quality "customers."

This definition appears to draw together the main elements of an integrated or total project materials and construction acceptance process.

In transportation construction and materials acceptance the term "quality assurance" is generally associated with a comprehensive program to gather data and supporting evidence that the work in-place is in conformance with specified quality levels. However, in *Managing Quality: Time for a National Policy* (*3*), Weed suggests, "This process involves people, materials, equipment, procedures, and the optimal use of these resources." While the report concentrates on the need for properly establishing statistical quality control specifications, it recognizes the need for a broad perspective on quality and quality management.

PURPOSE OF THE SYNTHESIS

This synthesis summarizes the current management techniques and factors influencing the testing and acceptance of materials and construction. The associated requirements for maintaining adequate qualified personnel to operate the acceptance and testing programs are also considered. State materials and construction acceptance practices encompass a broad range of topics. In addition to specifications and construction acceptance guidelines, personnel qualifications, prequalification of consultants and contractors, training requirements, and the impact of technology on state agencies are important to materials and construction acceptance.

SCOPE

The scope is focused on a wide variety of management and personnel issues related to acceptance procedures. The details of new material tests, statistical quality control procedures, and other technical data are beyond the scope of this work. However, technical aspects of some of these materials and construction acceptance procedures are included on the basis of their influence on personnel training requirements, changes in qualification requirements, and changes in administrative requirements.

In addition to the information obtained from the literature, this synthesis summarizes and reports the results of a detailed literature search: information obtained from a questionnaire distributed to Construction Materials Engineers and Personnel Managers; and information from selected agencies and organizations.

NEED FOR UPDATED QUALITY MANAGEMENT INFORMATION

This synthesis of the current practice is needed to describe the wide range of management techniques and approaches to inspection and testing of materials and construction. The changing contracting environment has created a need to highlight new and innovative strategies used by agencies to assure quality construction. Previous research and synthesis reports have considered various elements of these issues in detail. However, an overall view from the management perspective of the quality assurance process or construction quality management has not been published.

GENERAL SURVEY INFORMATION

A survey was conducted to solicit information on the wide range of issues in materials and construction acceptance practices. The survey was mailed to the 50 states, the District of Columbia, and Puerto Rico. Responses were received from 41 DOTs. The questionnaire was organized into five sections to obtain information related to:

- Contract Practices and Regulations
- Technological Changes
- General Management Issues
- General Responses
- Personnel Management.

A copy of the questionnaire is provided in Appendix B.

ORGANIZATION OF THE SYNTHESIS

Chapter 2 provides a summary of background information that is related to the primary topic of materials acceptance procedures. It briefly reviews materials appropriate to the wide variety of topics covered by the project scope. Chapters 3 through 5 are organized to discuss the surveyed subject areas. Chapter 3 reviews the current practices and agency responses to questions on contracting practices and regulation. Chapter 4 describes the survey responses to changes in management of technology and the general response category, which solicited information on innovative techniques. Chapter 5 reports on surveyed responses to management and personnel issues. Chapter 6 summarizes the synthesis findings and presents conclusions based on the findings.

CHAPTER TWO

BACKGROUND

The literature on the technical requirements of materials and construction acceptance processes has been well developed over the years. Articles and research reports have defined and redefined acceptance procedures and the statistics necessary to properly document the quality of materials and workmanship. Thus, many of the major elements affecting the management of materials and construction acceptance have been the subjects of previous synthesis reports, as indicated in Table 1. In addition to technical developments, management requirements have also changed over the past two decades. Although many management changes occurred, literature on contemporary management issues related to materials and construction acceptance was limited.

IMPORTANT DEVELOPMENTS

Many milestone events for materials and construction acceptance have been noted over the years. Several of the more prominent events need to be examined to put a historical perspective on the evolution of acceptance procedures for materials and construction. Probably the most frequently noted work influencing materials acceptance processes was the American Association of State Highway Officials (AASHO) Road Test conducted between 1956 and 1962. The evaluations showed that a larger than expected proportion of materials and finished pavements deviated from specifications. A congressional investigation on highway quality led to a similar conclusion. Records were so poor in some instances that it could not be ascertained if the proper materials had been used (*4*). In response to these problems, FHWA established a research program to incorporate statistical techniques into quality assurance programs.

Statistical quality control concepts were developed through various studies conducted on materials. *Quality Assurance Through Process Control and Acceptance Sampling* is an example of the publications produced during this developmental stage (*5*). This publication was designed to describe the fundamental philosophy of statistical quality assurance. The statistics and procedures are described along with examples of specifications and control charts. By the time *NCHRP Synthesis 65: Quality Assurance,* was published in 1979, 23 states indicated that they were using some form of statistical specification (*4*). Nineteen stated they only used end-result specifications. It was unclear, at the time the synthesis was prepared, whether the 23 states found that statistically based specifications were providing a cost benefit. The acceptance of materials by certification was also prevalent for a variety of manufactured materials. Many of the fundamental issues and acceptance processes described in the 1979 synthesis are evident today.

Investigations supporting development of performance-related specifications were conducted in the 1980s. The key findings are discussed in *NCHRP Synthesis 212* (*6*). The late 1980s, as evidenced by the pair of synthesis reports in 1989, had more activity on the administrative side. The content of these reports is discussed in more detail according to their subject coverage.

A more recent influence on materials and construction acceptance process is the Strategic Highway Research Program (SHRP). SHRP targeted improvements in technology for four areas: asphalt, concrete and structures, highway operations, and long-term pavement performance (LTPP). SHRP, which drew on the collaborative expertise of a large number of agencies and organizations, has generated more than 100 new products and techniques. Many of these are test procedures and specifications that have triggered renewed emphasis on statistically based specification procedures. SHRP is currently in the implementation phase where it will focus on the application of the research findings through various technology transfer systems (*7*).

TABLE 1
RELATED SYNTHESIS REPORTS

Synthesis Number	National Cooperative Highway Research Program (NCHRP) Synthesis Title [Publication Year]
38	Statistically Oriented End-Result Specifications [1976]
65	Quality Assurance [1979]
102	Material Certification and Material-Certification Effectiveness [1983]
120	Professional Resource Management and Forecasting [1985]
145	Staffing Considerations in Construction Engineering Management [1989]
146	Use of Consultants for Construction Engineering and Inspection [1989]
163	Innovative Strategies for Upgrading Personnel in State Transportation Departments [1990]
195	Use of Warranties in Road Construction [1994]
212	Performance Related Specifications for Highway Construction and Rehabilitation [1995]
232	Variability in Highway Pavement Construction [1996]

Concurrent with SHRP implementation, many other initiatives are occurring. Some are due to the revisions in 23 CFR 637, *Quality Assurance Procedures for Construction* (*1*). A key provision in this regulation permits the use of contractor test results in acceptance processes. This acknowledges the contractor's greater potential for quality control during the production process. The decision on using the contractor's results is left to the DOT. The decision is often based on personnel reductions or availability for a particular project. Further study on the economic and production quality impacts to the DOTs and the contractors will be needed. This should include the assessment of contractor test result reliability and improvements in the final product due to contractor process and quality control. This initiative is one of many evolving events that are continuing to shape materials and construction acceptance management processes. Although many events have shaped current practice, the evolution of the materials and construction acceptance practices will be examined through the changes in specifications, quality assurance, warranties, and personnel management.

CHANGING ROLE OF SPECIFICATIONS

This section defines each primary specification form and describes its relationship to the materials and construction acceptance process. The changing role of specifications is reviewed from the perspective that the traditional specifications are usually method-oriented, but today the emphasis is on performance and performance-related specifications.

Method Specifications

Traditionally, highway construction has focused on method specifications. Method specifications, also known as recipe specifications or prescriptive specifications, precisely describe the equipment, material, and procedure the contractor uses.

When using this form of specification, a supervising agency is obligated to monitor every aspect of the contractor's field operation closely, and the agency is then responsible for the outcome. By detailing exactly what was to be done, the expertise of supervising agency personnel was of extreme importance to the success of projects. A clear picture of the purpose of these traditional specifications is gained from a Miller-Warden publication in 1966 (*8*):

- Provide the contractor a definite basis for preparing his bid;
- Inform all representatives of the buyer as to what the contractor is obligated to do;
- Describe the desired procedures;
- State the basis for acceptance or rejection of the completed work, including sampling and testing methods;
- Provide rules for decisions on matters referred to the Engineer.

In addition to these functions, method specifications were seen as reducing job delays, contract claims, and escalation in future bid prices by ensuring that the work is done right the first time (*9*). Methods for payment were not identified as a function of method specifications, although they are an element of any specification. Two disadvantages of method specifications were identified: a complete description of the work process reduces innovation; and full-time personnel are required for proper enforcement. Elliot notes that methods specifications remove all responsibility for quality from the contractor, guidance for handling "out of specification" materials is generally lacking, and, by their nature, these specifications create adversarial relationships between the contractor and inspectors (*10*).

Implied within the "done right the first time" for method specifications is a great deal of control, or at least power, over the contractor's activities by the inspection/testing personnel. A contractor's success, in terms of the work performed, is measured on the basis of being "in substantial compliance" or "in reasonably close conformity." These imprecise terms are used to provide the DOT engineer or representative some latitude in the acceptance of the work performed by the contractor. This latitude is commonly referred to as "engineering judgment."

Method specifications are still widely used and "engineering judgment" continues to be exercised in the application of method specification acceptance procedures. For example, the conformity decision is described in the Pennsylvania Department of Transportation Specifications as (*11*):

> For each individual case, the Engineer will determine the limits of reasonably close conformity; the judgment given will be final and conclusive. If it is determined that material or the finished product in which the material was used is not within reasonably close conformity, but that reasonably acceptable work has been produced, the Engineer will then determine if the work will be accepted and remain in place. In this event, written documentation will be provided for acceptance by required contract modification, and/or to provide for an appropriate adjustment in the contract price for such work or material. If it is determined that material or the finished product is not within reasonably close conformity and has resulted in an inferior or unsatisfactory product, remove or replace it.

"Reasonably close conformity" is a judgment issue. It is thought that unless the Engineer consistently decides in favor of the contractor, the potential for a dispute exists with each decision.

Recognizing that there is some error or variation in results introduced by the materials, the construction process, and the testing method, the need for "engineering judgment" in method specifications is clear. This concept is captured best by McMahon and Halstead (*12*) as reported in *NCHRP Synthesis 65* (*4*).

> When traditional specifications [method] are combined with the skills of engineers, the complete cooperation of contractors, and the desire of everyone to do a good job, there is no doubt that a good highway can be built. However, inspectors and engineers must be capable of recognizing good materials and construction without relying solely on quality measurements.

Elliot (*10*) also notes that the inspectors must be knowledgeable, experienced, concerned, and fair. Given the well-documented loss of personnel in state agencies, knowledgeable, experienced personnel are becoming more difficult to find. This would suggest that the task of inspection is rapidly giving way to inexperienced inspectors, and more conflicts of interpretation are likely.

End Result Specifications

Given the known variability in the materials supplied and construction process, early end-result specifications were developed around measurable attributes or properties of the finished product, not the processes used to produce the product. Generally, end-result specifications place few restrictions on the contractor's selection of materials or methods, but the contractor is completely responsible for delivering the product in an acceptable fashion. Inspection and testing for end-result specifications has traditionally been a state DOT function.

Fewer problems with acceptance and rejection were identified for end-result specifications. Early "statistically based" specifications were developed with sampling plans, decision criteria for acceptance of the finished product, and a payment adjustment system. The statistical decision criteria and sampling concepts reduced many judgment problems by including an acceptable test variation allowance. The California Department of Transportation considered the effectiveness of statistically based end-result specifications compared to method specifications in a recent study. Based on the analysis of project data, it was concluded that the statistical end-result specification for asphalt paving provided better asphalt pavements than the state's method specification (*9*).

Even with the improvements offered by end-result specifications, Chamberlin identified three technical weaknesses of end-result or statistical end-result specifications as follows:

1. The inability to identify or measure essential performance-related characteristics of the end product;
2. The inability to quantify substantial compliance and to determine price adjustment factors that relate to reduced or enhanced value; and
3. The uncertainty as to value to be gained from the cost of implementing statistically based end-result specifications (*6*).

Many forms of statistically based end-result specifications continue to be used. In1993, more than half the states reported they were using some form of statistical quality control and quality assurance specifications. Another one-fourth reported they had statistical specifications in development (*13*).

Performance Specifications

Although statistically based end-result specifications offered some improvements over other specifications, a major criticism of the method and end-result approaches is that they do not necessarily measure characteristics related to performance. DOTs have more recently concentrated on development of specifications that relate to the performance of the completed product. The various forms of performance specifications were the focus of *NCHRP Synthesis 212*, which established a set of common definitions for these specifications because of the lack of uniformity and use of the specification terms in the literature (*6*). For example,

> A *performance specification* describes how the finished product performs over time. These specifications are not applicable to highway components because the technology is not sufficiently advanced (*6*).

The criteria for performance specifications are being developed from data collected on long-term pavement performance projects. These data may provide some guidance on how a true performance specification could be written. Development of testing procedures that reflect the performance of the pavement, rather than properties of materials, are in development. Many new technologies are also being considered, but few have progressed to the level of sophistication necessary for performance measurements.

> A *performance-related specification* describes the desired level of material and construction factors that have been found to correlate with fundamental engineering properties that predict performance. These factors are amenable to acceptance testing at the time of construction (*6*).

According to Chamberlin, the goal of a performance-related specification is not to improve the quality of construction. The goal is to identify the level of quality providing the best balance between cost and performance.

> *Performance-based specifications* describe desired levels of fundamental engineering properties that are predictors of performance and appear in primary performance prediction relationships. These properties are not amenable to timely acceptance testing (*6*).

Performance-based specifications desire to improve existing levels of quality by focusing on performance properties. Many material and construction product characteristics that relate to performance can be measured; however, in many situations the test results are reported too slowly for contractors to make adjustments to their processes.

Emerging Concepts

Elliot suggests that statistically formulated specifications, as a group, are quality assurance specifications (*10*). Two distinguishing features of quality assurance specifications are the recognition of construction product variability and the inclusion of provisions for handling out-of-specification construction. Neither of these issues is addressed in traditional method specifications.

The variability of paving materials and processes was the subject of *NCHRP Synthesis 232: Variability in Highway Pavement Construction* (*14*). Numerous changes in construction procedures, test methods, materials, and loss of experienced personnel are contributing to changing overall product variability.

Thus, where specifications are based on one set of conditions or assumptions, they may be invalid for current materials and equipment. *NCHRP Synthesis 232* provides an in-depth discussion of variability, including discussion of SHRP procedures. It concludes with recommendations on development of more realistic specification limits. The fundamental basis of specification development is changing along with other quality assurance processes.

QUALITY ASSURANCE PROCESSES

Traditional forms of specifications serve both quality control and quality assurance functions. The role of state and local DOTs is moving toward providing a quality assurance function and away from performing quality control. Concurrently the contractor's role is evolving toward total responsibility for quality control. Quality assurance is defined as:

> All those planned and systematic actions necessary to provide confidence that a product or facility will perform satisfactorily in service. Quality assurance addresses the overall problem of obtaining the quality of service, product, or facility in the most efficient, economical, and satisfactory manner possible. Within this broad context, quality assurance involves continued evaluation of the activities of planning, design, development of plans and specifications, advertising and awarding of contracts, construction and maintenance, and the interactions of these activities (*15*).

Discussion of traditional quality assurance systems is based on the type of specification system used and perhaps the project delivery system. The more traditional system is when the contractor works within a very controlled environment like that in a method specification project. Assurance, using method specifications, is based on the owner having complete control of the process and enumeration of contractor means and methods. Detailed owner-directed inspection is the primary control process, and final acceptance of the work is essentially automatic. Representative sampling can be used as an intermediate accept and reject criteria.

Most DOT contracts that include quality control/quality assurance processes assign the responsibility of developing a quality control program to the contractor. The DOT typically provides guidelines on the necessary tests and inspection controls. The DOT's role is to approve the quality control program, monitor contractor procedures, test results, perform independent tests, and determine acceptance. The Federal Aviation Administration (FAA) uses a quality process similar to DOT processes. The FAA contractor quality control program requirements are provided in Appendix C.

Many acceptance procedures have established criteria for awarding partial payment for work of lessor quality or a bonus when the work is of higher quality. Unlike traditional specifications where the decision was predominately accept or reject, the payment adjustments are ideally a cost that is proportional to the anticipated gain or loss in performance.

WARRANTIES

A construction warranty is a quality management technique that considers long-term performance requirements. Warranties were not acceptable on federally supported projects before 1993 and even now are only allowed for limited conditions. Today, warranties may be included in National Highway System (NHS) construction contracts for specific construction products or features, excluding maintenance items that are not eligible for federal participation. The use of warranties on NHS construction must receive advance FHWA approval. The DOT can follow its own procedures for including warranties on non-NHS Federal-aid contracts.

This section summarizes key elements related to materials and construction acceptance drawn from *NCHRP Synthesis 195: Use of Warranties in Road Construction* (*16*), published in 1994. Since performance specifications are related to how well a pavement or structure performs over time, a warranty becomes a natural extension of the performance specification acceptance process. A warranty is a guarantee of the integrity of a product and of the maker's responsibility for the repair or replacement of deficiencies. It places an absolute liability on the part of the warrantor and the contract is void unless it is strictly and literally performed. Usually it is applied to manufactured products and their qualities, but can be applied to construction.

Performance bonds commonly cover work for a period of one year after completion of the project. Warranties imply a longer-term obligation and, therefore, involve the long-term performance of the constructed facility. In 1994, seventeen DOTs reported using warranties, but generally their warranties only covered performance of products such as landscaping, equipment, and traffic marking materials. This type of warranty functions in a manner similar to traditional one-year maintenance bonds.

The major benefits expected from warranties are improved construction quality and possible maintenance cost reductions. Three major concerns with warranties were reported:

- Unknown cost impact,
- Inability to define the performance required and measurement methods, and
- Inability to determine true cause and responsibility for failures on projects (legal disputes).

Other concerns expressed about warranties were the DOT's ability to manage and enforce warranties and the willingness of the sureties to honor warranty commitments.

Few suggestions were provided for revisions to standard acceptance criteria when warranties are included in a project, other than clearer definition of long-term performance criteria. It was noted that a future consideration would be to continue development of performance-related design, specification, and inspection. The identity of the constructed product elements most likely to be accepted under a warranty contracting procedure is unresolved.

MATERIAL CERTIFICATIONS

A certification is a written statement from a vendor stating that their supplied materials are in compliance with specification requirements. Certifications are generally used to document that the contractor has used materials that comply with the owner's quality assurance requirements. Materials or products that are manufactured with dependable quality control programs are likely to be successful candidates for acceptance by certification. Agency verification testing is required to ensure the certification is representing an acceptable material. Certification procedures usually list sampling and testing requirements (*17*).

Not all materials and components lend themselves to certification. Unprocessed native materials, soils and aggregates, are seldom accepted on the basis of certification because of wide variation in natural deposits. The primary exception to unprocessed material certifications might be plants, shrubs, and similar plantings. Certifications have been used in a few states for aggregate supplies, topsoil, and soil for embankments. Component materials such as asphalt binders, portland cements, additives, and reinforcing steel were accepted by certification in about half of the agencies. Acceptance plans have been developed to allow certification processes to be used for some plant prepared materials, including aggregates, provided the supplier has a satisfactory quality control program in place. Annual plant inspection and testing are the primary quality controls to monitor certified materials supplier performance.

PERSONNEL MANAGEMENT AND QUALITY ASSURANCE

Previous synthesis reports and related materials were reviewed for personnel issues related to materials and construction acceptance. A recurring theme in each report was the need to address loss of expertise in DOTs due to retirement, attrition, and layoffs.

Resource Management Forecasting

The changing emphasis in DOTs, from testing and quality control to quality assurance, will have a significant influence on personnel requirements. *NCHRP Synthesis 120: Professional Resource Management and Forecasting*, completed in 1985, was chartered to examine the factors that affect professional resource management, identify the elements of professional resource management, and identify programs in operation at the time the synthesis was prepared (*18*). The need for this work included considerations of retirement and attrition policies, use of consultants, impact of technological advances, and changes in the character of the highway program, among others. The report identified six elements of a professional resource plan:

- An overall organizational analysis that attempts to identify the professionals needed to achieve the agency's goal (this could include projected changes in work load, labor mix, and departmental policies);
- An analysis that determines the behavior and skills necessary to perform specific tasks;
- Person analysis that seeks to identify skills and abilities an individual needs to perform specific tasks;
- Recruitment policies and programs, including the number of and level of recruits;
- Projected shortages in specific professional categories that can be determined by analysis of data on external labor demand and supply, as well as internal departmental data on the age, structure, and projected retirement of employees; and
- Training and promotion plans for various professional categories.

At the time the report was written, Minnesota, North Dakota, and Virginia provided information on their agency-wide programs. California, Maine, Pennsylvania, and New York used personnel requirements as part of capital program planning.

It is notable that in 1985, when the synthesis was written, no shortage of engineers was anticipated and no mention was made regarding projections for technicians. Five years later, however, much had changed. "Many state departments of transportation (DOTs) are currently facing shortages of professional personnel, primarily civil engineers." This was the lead statement in the introduction to *NCHRP Synthesis 163: Innovative Strategies for Upgrading Personnel in State Transportation Departments* (*19*). Demand variation among agencies was fairly large due to attrition rates, available market, and program size. With regard to the availability of fewer personnel, the report indicated that upgrading existing employees would not meet the demands imposed by program growth. One possible strategy to replace lost DOT capability is the use of consulting engineer inspectors.

Staffing Concerns

NCHRP Synthesis 145: Staffing Considerations in Construction Engineering Management was initiated because the DOTs were concerned that experienced, trained personnel were lacking (*20*). Little was found in the literature regarding staffing of construction projects at the time. The conclusions (provided below) attempted to respond to several questions related to this topic:

- Many agency staffs are not adequate for the current workload without outside assistance.
- Assigning quality control responsibilities to the contractors is feasible, providing: the agency's testing and inspection procedures include random spot checks to ensure that quality material is produced and incorporated into the project; a certification procedure is adopted to ensure that contractor's technicians are, in fact, qualified; and specifications are defensible with reasonable price adjustments.

The report recommended development of staffing guidelines, additional study of agency attrition problems, determination of training needs, and establishment of contractor personnel requirements at the same level as agency personnel.

TABLE 2

ADVANTAGES AND DISADVANTAGES—CEI USE *(21)*

Advantages	Number of Respondents
Improves ability to handle peak work loads	15
Makes it easier to control in-house staff size	12
Provides flexibility to add or reduce staff more quickly	9
Provides special expertise not available in-house	7
Makes it easier to staff difficult projects	2
Makes it easier to obtain equipment, offices, etc.	1
Is more competitive	1
Is in keeping with state's goal of increasing privatization	1
Disadvantages	
Costs are higher	11
Familiarity with procedures is lacking	9
Monitoring requires a duplication of effort/increased paper work	8
Consultant forces may be poorly qualified	7
Training opportunities for in-house personnel are lost	5
Training of consultant personnel must be continual	5
Salary disparities cause in-house morale problems	3
Control and responsiveness are lost	2
Consultants recruit agency employees	1
Consultants are more concerned with protecting themselves than the agency	1

Use of Consultants for Inspection

Consultant engineering and inspection (CEI) services have been used for some time. This topic became the primary focus of *NCHRP Synthesis 146: Use of Consultants for Construction Engineering and Inspection* (*21*). Completed in 1989, the synthesis noted that a driving force behind agencies shifting workload over to consultants was the staff reductions experienced in the previous decade. Consulting firms are primarily used to supplement agency staff and handle peak loads. The study findings on the advantages and disadvantages of CEIs are provided in Table 2.

Consultants believed that they provided better-qualified and trained personnel for projects than the DOTs. Based on the review of common staff qualifications required by states, more DOTs required professional registration for CEI engineers than for their own engineers performing the same task. Technician qualification requirements were more balanced. The two predominate qualification criteria were existing agency technician classification schemes and experience. The top five criteria used for CEI consultant selection (identified by at least 10 states) were:

- The qualifications and experience of the available staff members,
- Past performance of the firm, especially performance for the agency,
- Specialized expertise for the specific project,
- The firm's current work load and ability to meet the schedule, and
- Location of the firm's office with respect to the project.

Among other criteria noted were the price; familiarity with specifications, work processes, and project; and professional reputation of the firm.

Some of the recommendations from *NCHRP Synthesis 146* also should be noted:

- Agencies should use staffing guidelines and manpower management systems to assess staffing needs to determine the need for outside assistance.
- Agencies should retain sufficient CEI work in-house to provide training opportunities to maintain a trained work force capable of adequately administering consultant CEI contracts.
- Agencies should specify minimum requirements for both engineers and technicians in the requests for proposals, to ensure that consultants understand the qualifications expected and to make evaluation of proposals easier.
- CEI consultants should require, or at least encourage, their technicians to become certified in an appropriate certification program. At this time, the National Institute for Certification in Engineering Technologies (NICET) program meets the need in highway construction engineering and inspection better than other identified programs do.
- Agencies should check the calibration of consultant test equipment and monitor testing procedures to ensure test accuracy.
- Agency accounting systems should be modified to afford managers the ability to determine the true cost of construction engineering, whether agency personnel or consultants perform it. Only then can a true cost comparison be made.

The time to process CEI contracts ranged from 3 weeks to 9 months. More typical values ranged from 4 to 5 months from the time the request for proposals was released and the approval made. This clearly points to the importance of forecasting staffing needs for the start of upcoming construction programs.

Use of Contractors in QC/QA Process

The use of contractor quality control test data to aid the quality assurance decision on DOT construction projects is relatively new. Few references in the literature were found.

The Federal Aviation Administration contractor quality control requirements enable a contractor to:

- Adequately provide for the production of acceptable quality materials,
- Provide sufficient information to assure both the Contractor and the Engineer that the specification requirements can be met, and
- Allow the Contractor as much latitude as possible to develop his or her own standard of control (22).

The continued use of consultants and contractors in materials and construction acceptance processes indicates that many of the factors influencing DOTs to seek external expertise and assistance have not changed.

NCHRP Synthesis 65: *Quality Assurance,* noted that agencies using statistical approaches usually assign total responsibility for quality control to the contractor. Quality control would be those activities conducted by the contractor to assure that materials and construction conform to specification requirements. Acceptance tests are those performed by the DOT to assure satisfactory quality control has been exercised. The common interpretation of assurance sampling and testing is that independent samples are taken to measure the quality control process.

FEDERAL HIGHWAY ADMINISTRATION

As noted earlier, the final rule on the *Quality Assurance Procedures for Construction* was published in the Federal Register in June of 1995. This imposes significant changes (both allowed and required) in materials and construction acceptance processes. It permits the use of contractor test results in the acceptance process and the use of consultants in independent assurance and verification programs. The rule requires that each DOT develop a quality assurance program that provides for an acceptance program and an independent assurance program. Required in the acceptance program are:

- Verification sampling and testing frequency guide,
- Verification sampling and testing location, and
- Identification of test attributes reflecting product quality.

Quality control sampling and testing results may be used as part of the acceptance decision provided that:

- Sampling and testing have been performed by qualified laboratories and personnel,
- Quality of the material has been validated by verification sampling and testing requiring independent samples, and
- The quality control sampling and testing is evaluated by an independent assurance program.

An important aspect of the regulation was a mandate to testing laboratories requiring that:

a) Laboratories.

   1) After June 29, 2000, all contractor, vendor, and SHA (State Highway Agency) testing used in the acceptance decision shall be performed by qualified laboratories.
   2) After June 30, 1997, each SHA shall have its central laboratory accredited by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA.
   3) After June 29, 2000, any non-SHA designated laboratory, which performs Independent Assurance (IA) sampling and testing, shall be accredited in the testing to be performed by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA.
   4) After June 29, 2000, any non-SHA laboratory that is used in dispute resolution sampling and testing shall be accredited in the testing to be performed by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA.

b) Sampling and testing personnel. After June 29, 2000, all sampling and testing data to be used in the acceptance decision or the IA program shall be executed by qualified sampling and testing personnel.

c) Conflict of interest. In order to avoid an appearance of a conflict of interest, any qualified non-SHA laboratory shall perform only one of the following types of testing on the same project: Verification testing, quality control testing, IA testing, or dispute resolution testing.

BACKGROUND SUMMARY

The lead references highlighted a wide range of topics that influence materials and construction acceptance management practices. Some of the key issues are listed below.

- Specifications are evolving from method specifications toward performance-based specifications, although method specifications will be retained for many applications.
- The next generation of performance specifications is likely to include parameters reflecting more realistic expectations of variability.
- Warranties create many new opportunities, but were not implemented until recently and only on a very limited basis.
- Certifications have been used to accept nearly all materials, with the exception of native materials.
- Studies reviewing DOT staffing practices and the use of external consultants or contractors in the materials and construction acceptance indicated a few states using forecasting techniques capable of identifying what skills would be needed.
- The most recent influence to surface in the background study was the FHWA final regulation on quality assurance procedures.

CHAPTER THREE

CONTRACT PRACTICES AND REGULATIONS

Materials and construction acceptance is a combination of administrative processes and technology. Information about current management practices of DOTs was collected in September 1996 using the survey form in Appendix B. Forty-one responses were received from the 52 questionnaires sent out. Not all DOTs responded to all the sections in the questionnaire, so reported response totals vary. Also, many DOTs distributed the survey to a number of people for response, because of the diversity of topics in the questionnaire. The individual sections were combined to represent a single DOT response. General comments and other information provided on the surveys were maintained in independent records. Many DOTs provided the supporting documents requested in the survey.

The questions, from the questionnaire in Appendix B, appear in the text as bold italic section headings. Each survey question is followed by a brief discussion of the survey question, response patterns, and is summarized with the overall DOT consensus where appropriate. Example comments or documents were chosen to illustrate specific DOT practices. The illustrations were not valued as best practices or recommended practices, but they often represent a specific or unique treatment of a subject.

The survey responses were divided into three chapters. Contract practices and regulatory issues are discussed in this chapter. Management of technology and management of personnel issues are presented in chapters 4 and 5 respectively.

REGULATORY ISSUES

Regulations govern many of the activities of DOTs. A key concern regarding the latest FHWA quality assurance regulation was a DOT's ability to begin implementation without regulatory authority. The use of contractor test results in decision-making and use of consultants in the quality assurance process were the two primary points of inquiry. The survey covered this topic with a broad question on regulation restrictions.

Do you know of any state legislation or other restrictions that would prevent your agency from using contractor test results or consultant testing for assurance as established by the guidelines in 23 CFR 637?

23 CFR 637 was rewritten in 1995 to permit state DOTs to use contractor or consultant's test results in the acceptance of materials and construction. This is only an enabling regulation: the DOTs are responsible for implementation. State administrative and procurement procedures may require that only measurements by independent parties be used in the acceptance decision process.

Thirty-nine responses indicated no specific problem related to use of contractor test results in quality assurance decisions, and two did not provide a response to the question. Georgia indicated agreements with consultants were allowed, with special state approval. Thus, it appears there is little in the way of administrative problems related to using contractor quality control tests or consultant assurance tests in the materials and construction acceptance process.

CONTRACT PRACTICES

The contract documents that govern project execution are similar for all DOTs. However, some have modified their contracting practices to include, for example, warranties, special qualification criteria, or quality incentives. The group of questions that follows were targeted to identify new or revised contracting practices in materials or construction acceptance. Warranties, contractor quality control programs, and consultant quality assurance processes were key management issues that have been influenced by recent regulatory changes. Specification incentives and disincentives, regional specifications, and dispute resolution mechanisms for testing are also influential elements in materials and construction acceptance.

Does your agency incorporate warranties in the construction acceptance process?

Thirty-three of the 41 DOTs responded that they were not using warranties in the construction acceptance process. Seven DOTs responded that they were using warranties for construction acceptance. One respondent did not provide information about their agency's plan for warranties.

Twenty-three of the DOTs not using warranties provided additional comments as follows:

1) Twelve indicated they were in some stage of considering warranties,
2) Five said they were "looking at" the use of warranties at this time,
3) Four indicated they would drop or limit the amount of inspection and testing on warranted work when it was implemented, and
4) Two responded they would consider implementation with no impact to their testing and inspection program.

Of the seven DOTs using warranties, several provided additional information on their specific applications of construction warranties. The impact it has had on testing programs was also reported.

• Arkansas reported using warranties on traffic signals and rest areas.

• Maryland eliminated paint and preparation inspection and testing by the use of warranties.

• Puerto Rico reported using warranties for mechanical and electrical items.

• Wisconsin and Indiana reported that they eliminated testing requirements for warranted work (bituminous concrete paving).

The number of DOTs using warranties is consistent with the synthesis study completed in 1994. That study noted that most warranties were 1-year performance or maintenance bond requirements, and not multi-year warranties based on constructed facility performance.

Indiana and Wisconsin have experimented with 5-year warranties on pavement projects. Wisconsin has had more extensive experience with warranties and plans to have seven projects screened for warranties in the 1998 construction season. Indiana completed its first warranty project in 1996. Only the mainline paving is considered under the warranty provisions, while other project work is accepted using more traditional procedures. Performance criteria for the warranty period are established before the start of the project. Indiana established the performance criteria with industry participation. Wisconsin relied on the data from pavement management program records. In both DOTs the criteria were established using performance objectives. For example: roughness, friction, rutting, and cracking would be typical warranty performance criteria measured at predetermined time intervals.

The contractors for these projects established their own quality control and quality assurance procedures. The contractor on the warranted work is actually performing the quality assurance for their work. Neither DOT performs traditional quality assurance testing on work related to the warranty items. Indiana performed some independent sampling for project monitoring purposes, since this is their first experience with a warranty. Wisconsin estimates the DOT's tests are 10 percent or less of the total quality assurance sample, but only the contractor tests are used for acceptance and payment evaluations. Neither Indiana nor Wisconsin performs any quality control testing.

Wisconsin DOT currently has warranty specifications for asphalt pavement built over a portland cement concrete and asphalt pavement built over a granular base. The contractor is responsible for asphalt mixture(s), pavement performance, and warranty work on the finished roadway for 5 years following completion of the work. The warranty is a single term, 5-year warranty bond that ensures proper and prompt completion of warranty work.

The Wisconsin specification establishes procedures for a conflict resolution team. The resolution team is composed of a five-member panel. The contractor and the DOT each select two members and the fifth member is selected by mutual agreement. The specification itself is unique in many ways, but the criteria of performance are the critical points that need to be defined. The current version of the Wisconsin specification identifies 12 distress types. Threshold acceptance levels for each type of distress and required remedial action are defined. These are provided in Appendix D. The basis of payment is a comprehensive unit price per ton for the pavement and shoulders. Compensation includes furnishing, preparing, hauling, mixing, placing of all materials; the warranty work; a quality control plan; testing, record keeping, sampling; traffic control; and all other labor, tools, equipment and materials incidental to the work.

Do you evaluate contractor quality control systems as part of the prequalification process for bidding on projects?

Not all DOTs use a prequalification process for considering a contractor's capability for performing work. Traditional prequalification systems are heavily weighted toward financial capability and work experience. However, this question raises the issue of evaluating a contractor's testing and quality control capacity. Only Connecticut, Maryland, and New Jersey replied that they considered quality systems information in qualifying contractors to bid work. Connecticut indicated that they prequalify on the basis of financial capability and experience. Maryland evaluates quality control plans in those instances where the prime contractor happens to be the hot-mix asphalt producer and laydown operator. Thus, the contractor's whole operation is evaluated prior to approval. New Jersey plans to include more quality evaluation of contractors in the future. Iowa commented that they would remove a bidder who failed to meet minimum qualifications.

Contractor quality plans were discussed in chapter 2, however the DOT in New Jersey has implemented quality assurance programs for consultant design contract proposals that bear mention here. They require the consultant to submit a quality assurance plan. Key headings from the New Jersey *Consultant Quality Assurance Program Plan Guidelines* include the following (*23*):

Quality Control Policy
Project Organization with responsibility assignments
Quality Control System
Contract Review
Design Control
Document Control
Purchasing
Process Control
Control of Nonconforming Product
Corrective and Preventive Action
Control of Quality Records
Internal Audits
Training.

Quality-based prequalification is the focus of the current NCHRP Project 10-54, *Quality-Based Performance Rating of Contractors for Prequalification and Bidding Purposes.* The objectives of this project are to (1) develop a quality-based system for performance-rating contractors for either prequalification or bid-selection and (2) prepare an implementation plan as a guide for DOTs and industry. One of the driving forces mentioned in the research problem statement was that "transportation agencies are under pressure to reduce personnel—thus reducing the ability to provide close project oversight—without degrading the quality of the construction process and the final project." Contractor workmanship and compliance with the specifications are critical elements of such evaluations. This clearly anticipates further changes in the DOT's role in materials and construction acceptance.

Do you contract with any "outside" agencies to provide quality assurance or acceptance testing?

Hiring outside consulting or testing firms as an extension of DOT forces is a common practice. This question was targeted toward identifying what the state of the practice is in regard to contracting with other groups to provide assurance testing. Only 39 complete responses were received from the 41 surveys returned. Twenty-two indicated that they do not contract with outside agencies for quality assurance and acceptance testing. Seventeen indicated they did contract at least some quality assurance testing outside their workforce.

The need for contracting quality assurance and acceptance testing was attributed to a range of issues. Seventeen surveys indicated why they used contracted services as follows:

1. Staff reductions and lack of personnel (10 responses),
2. Lack of qualified personnel (3 responses), and
3. Balancing seasonal workload (4 responses).

Seasonal workload and reduced staff size are resource availability problems. DOT staff sizes have been steadily reduced over the past 10 to 15 years, and any increase in programmed work creates seasonal or peak workload personnel shortages. One other reason noted for contracting inspection services was for out-of-state inspections of material or equipment. The DOT in the material producing state would be requested, by another DOT, to provide on-site evaluations of the supplier. This is an effective approach to inspecting materials at the source without requiring a significant amount of travel by inspection personnel.

Advantages—Those listed for using outside testing agencies were primarily balancing workloads and using the consultants as an extension of staff. Two respondents, who use contracted testing for out of state materials inspections, indicated that this practice was cost-effective for them. Two respondents indicated that the only advantage to this practice is that the "inspection gets done," and two others knew of no advantages to contracting out.

Disadvantages—These comments were varied. A predominant concern was the DOT's ability to audit the firm performing the inspections or tests. Of the nine respondents who agreed with this, two also noted that decisionmaking abilities of consultants were poor. Decision making in this context was related to practicing "engineering judgement" in the acceptance process and other quality related decisions. Six respondents noted hiring unqualified or inadequately trained consultants to do this testing as an issue. Other responses were concerned with union resistance to the practice, potential for losing agency expertise, and when hired firms are not dedicated to DOT goals.

The required qualifications for "outside" testing agencies ranged from none to very detailed requirements. Arizona's system is representative of a program that defines specific requirements for materials testing laboratories working on Arizona DOT projects. Eligible laboratories are periodically evaluated to verify compliance with the requirements. Arizona's visitation process parallels the AASHTO Accreditation Program (AAP) which is discussed in more detail in chapter 4. Arizona requires AAP accreditation in those areas the laboratory performs DOT testing. Their inspection and evaluation criteria requires demonstration of tests, written policy and procedures including a correlation testing plan for portable or satellite facilities, and copies of AASHTO Materials Reference Laboratory (AMRL) and Cement and Concrete Reference Laboratory (CCRL) inspection reports. The laboratories are also required to participate in Arizona DOT's proficiency sampling program. Personnel qualifications for supervising technicians are one of the following:

a) Certified by the National Institute for Certification in Engineering Technologies (NICET) at Level III, or above, in the appropriate field and subfield in which work is directed.
b) Registered as a Professional Engineer in the State of Arizona with one year of applicable experience that is acceptable to the Department
c) Certified as an Engineer-in-Training by the State of Arizona with two years of applicable experience that is acceptable to the department.
d) Obtained a Bachelor of Science Degree in Civil Engineering, Civil Engineering Technology, Construction Engineering, or related field acceptable to the Department, with three years of applicable experience that is acceptable to the department.
e) A NICET certified Engineering Technician, or above, in Civil Engineering Technology, with five years of highway experience that is acceptable to the Department.

Arizona technicians performing actual sampling, testing, or inspection must meet one of the following requirements:

f) Certified at Level II, or above, by NICET in the appropriate field and subfield, acceptable to the Department
g) An individual listed in (a) through (e) above, if proficiency has been demonstrated in performing the appropriate sampling, testing, or inspection function.
h) Enrolled in the appropriate field and sub-field of the NICET certification program, acceptable to the Department, and under the direct observation of an individual listed in (f) or (g) above.

To perform referee testing on Arizona DOT projects as an independent testing laboratory, a laboratory must provide proof of its independent status. Testing firms must be devoid of ownership in any participant contractor or material supplier performing work for the department.

Are quality incentives and disincentives used in your specifications?

Incentives and disincentives are widely used in the materials and construction acceptance process. Of the 41 surveys, 35 responses reflected some form of incentives or disincentives; five indicated they did not use them; and one survey had no response to the question. Most of the incentives and disincentives referenced by the respondents were related to pay factor adjustments. Examples of pay factor equations are provided by Pennsylvania's concrete paving specification and South Carolina's hot-mix asphalt specification. Each DOT's formulation of pay factor equations is slightly different, but the variables chosen often measure the same characteristic.

Pennsylvania has a payment adjustment formula for reinforced or plain concrete pavements, Section 506, under its restricted performance specification.

$$L_p = C_p \left[\frac{(2Ps + 2Pd + Pa)}{500} + \frac{(Pp - 100)}{100} \right]$$

where:

L_p	=	Lot payment
C_p	=	Contract price per lot
P(s)	=	Payment percent of contract unit price strength
P(d)	=	Payment percent of contract unit price depth
P(a)	=	Payment percent of contract unit price air content
P(p)	=	Payment percent of contract unit price profile index

Payment percentages are determined from tabulated values that relate lot test results to the appropriate pay adjustment. Of the four attributes measured for lot payment adjustment, the only factor whose upper limit represents a quality incentive is the profile index, which can be allocated 105 percent of the contract unit price, when no other profile corrections have been made. The other factors can be paid to 100 percent of the contract unit price. For a contractor to receive an incentive payment, all other factors must also be maintained at a high quality performance level.

The total lot payment for hot-mix asphalt (HMA) mixtures is handled with three attributes in South Carolina:

$$\text{Total Price Adjustment} = 0.3\,(A) + 0.5\,(B) + 0.2\,(C)$$

where:

A	=	% bid price factor for asphalt binder content
B	=	% bid price factor for air voids
C	=	% bid price factor for VMA

There are incentives in the Bid Price Factors for asphalt binder content and air voids that range up to 104 percent. The voids in mineral aggregate (VMA) has a maximum value of 100 percent.

These two example formulations provide a limited insight to pay factor adjustment formulations. Table 3 illustrates a selected list of specification areas where DOTs responded to using incentives and disincentives in their payments.

The survey requested that respondents consider the advantages and disadvantages of incentives and disincentives in the materials and construction acceptance process. The numbers indicate the number of respondents that listed that advantage. The totals reflect multiple responses from the DOTs. The advantages to these specifications were noted as follows:

- The quality from contractors has improved. (9)
- The contractors are more aware of their product. (5)
- The contractors provide smoother pavements. (5)
- The contractor is rewarded for work exceeding the specifications. (2)
- DOT has increased conformance with specifications. (2)
- HMA quality has improved for all properties. (2)
- The user delays are reduced. (2)
- The better contractors are bidding on anticipated incentives. (1)
- The disincentives capture the attention of the contractor to enlist their fullest cooperation. (1)
- Reduced contractor litigation is anticipated. (1)
- DOT specifications are easier to write. (1)

Two respondents noted that their contractors complained that the incentives were too difficult or impossible to achieve. Both rationalized that the purpose of the incentive was to reward exceptional performance not just better than specified. Statements in the surveys were "The department does not plan for the payment of incentives to become routine or commonplace. The intent of these incentives are to pay only for exceptional work, not work that only meets the minimum specification." The other said they "could probably obtain a satisfactory level of quality without incentives using disincentives only."

In contrast to this position was another state's comment on incentives that said, "we have to be careful that we do not spec something that is not reachable, putting contractors and producers in a no-win situation." Weed, in a 1994 paper stated: "Unless the adjusted pay schedule is designed to allow bonuses and reductions to balance out in a natural way, the average pay factor will be biased downward at the AQL (acceptable quality level) and acceptable work may be unfairly penalized (*24*)." This balance is difficult to achieve, as noted in the disadvantages listed as follows:

- We accept work that does not meet specification by reducing costs. (1)
- The contractors have come to expect incentive payments. (1)
- Rideability may only provide a short term benefit. (1)
- The incentives and disincentives are easy to recommend, but difficult to implement. (1)
- Contractor uses maximum water content to obtain smooth concrete pavements. (1)
- They add an extra administrative burden. (1)

TABLE 3

SPECIFICATION ATTRIBUTES WITH INCENTIVE/DISINCENTIVE FACTORS

State	HMA Density	HMA Mix	Asphalt Content	Aggregate Gradation	HMA Thickness	Smoothness/ Rideability	Concrete Strength	Water to Cement Ratio	Aggregate Quality	PCC Depth	Bridge Deck Smoothness
Alabama	✓	✓	✓			✓					
Alaska	✓			✓							
Arkansas		✓				✓					✓
Arizona						✓					
Connecticut	✓			✓							
California	✓	✓	✓	✓							
Florida											
Illinois					✓	✓					
Indiana						✓ (PCC)					
Iowa						✓					
Maine	✓		✓	✓			✓				
Maryland	✓		✓	✓		✓					
Michigan	✓					✓	✓				
Minnesota						✓		✓	✓		
Missouri						✓					
Nebraska						✓					
New Hampshire		✓									✓
New Jersey		✓				✓	✓			✓	
New Mexico	✓	✓	✓	✓							
Nevada		✓									
North Carolina						✓					
North Dakota						✓					
Ohio						✓ (HMA)					
Oklahoma	✓		✓	✓		✓	✓		✓	✓	
Pennsylvania	✓		✓		✓	✓	✓			✓	
Puerto Rico											
Rhode Island											
South Carolina	✓				✓ (base)	✓					
Tennessee			✓	✓		✓					
Texas		✓				✓					
Utah	✓		✓	✓							
Vermont		✓									
Washington	✓		✓	✓							
West Virginia											
Wisconsin						✓					
Wyoming	✓			✓		✓			✓	✓	

TABLE 4

A SAMPLE OF SMOOTHNESS SPECIFICATIONS PAYMENT ADJUSTMENTS

State	Maximum Price Incentive Adjustment (Percent of Unit Bid Price)	Profile Index (PI) Requirements
Alabama	105	Under 3 inches/mile/section
Arkansas	105	Under 2 inches/mile/0.1 mile section
Maryland	100	Decreasing payment factors start at 0.98 for 0.1 to 1.0 inches/mile/0.1 mile for PI exceeding specified minimum
Michigan	100% bonus for 0.0 inches/mile decreasing at 0.25% for each 0.01 inches per mile to a bonus factor of 0 for 4 inches/mile	Incentive payment schedule is a bonus payment only applies for pavements qualifying for 0 to 4 inches/mile
Nebraska	105	For 0 mm to 30 mm per lane—kilometer
Pennsylvania	105	For 3 inches/mile or less
Wyoming	5% payment incentive	Daily average PI must be less than 80 mm/km and maximum is earned for PI less than 40 mm/km

• (Our) experience has been paying more for the product than we should. (1)

• Items with incentives and disincentives drive production, and qualities of the product may be sacrificed to achieve the incentives. (1)

If it is accepted that in the process of establishing incentives or disincentives the role of the specification writer is to balance the risks of both parties, there are a variety of approaches to achieving the goal. Table 4 illustrates the variety of bonus or incentives and disincentives for smoothness specifications. The list is not intended to be exhaustive, only to illustrate the variation in types of adjustments used for a single factor. One common feature among the listed factors is a consistent cap on maximum payments at 5 percent above the base unit bid. The profile index values that trigger bonus payment and the range of payments possible vary among the DOTs. Maryland's specification contains only a disincentive clause, no incentive is included. However, the measurement index is measuring the variation from a specified profile index.

Do you use regionalized specifications which tailor specific clauses for materials or acceptance due to local material availability or practices?

Thirteen responses indicated that they used some form of regional specifications, generally to take advantage of local material supplies. The predominant use of regionalized specifications was for aggregates.

Advantages

• Better selection of aggregates

• Better product quality and economics when designed for the area

• Able to use local materials which minimizes haul road damage

• Use of slag aggregates

• Better use of aggregate pits.

Disadvantages

• Work well in small state construction program, but are very method oriented

• Could possibly be getting a product of lesser quality, which will cost more in long run

• Lack of material uniformity throughout state

• If the specifications are improperly used they may be more costly

• Quality is compromised by regional specifications

• District engineers can specify materials within district based on availability. Contractors complain that we cannot decide what we want.

Regional specifications can be used for tailoring material requirements when statewide variations are large enough that they impact quality. The process establishing the distribution pattern and other acceptance requirements was not included in the scope of this question.

Do you have a dispute resolution mechanism in your quality assurance program for instances when assurance tests do not agree with consultant or contractor tests?

Twenty-five respondents indicated that they had a dispute resolution mechanism for test results and provided information on their process. Resolution techniques were administrative, investigative, or a combined process. The purpose of the investigative methods is to identify the potential source of testing error. Once the source of error was identified, the retest procedures were often identified as the resolution mechanism. The administrative methods were generally the dispute resolution mechanisms. The following specification paragraph highlights the combined investigative-administrative process. The first attempted resolution is validation of the test data and additional investigation. Failing identification of the test discrepancy, the administrative decision determines a pay factor based on the DOT tests only.

> If the statistical comparison validated the test data, pay factor determination will be based on all test data, both the Department's and the Contractor's, for that particular material and property. If the statistical comparison does not validate the test data, then the Project Manager and Process Control Technician shall investigate to determine the reason for the discrepancy. If the investigation identifies the reason for the discrepancy, the data set containing the faulty data will be corrected or eliminated from consideration, as appropriate. If the reason for the discrepancy cannot be resolved, then pay factor determination will be based on the Department's test values only. In the event that individual test values are suspect, the data in question shall be evaluated using "Standard Practice for Dealing With Outlying Observations," ASTM E 178, with appropriate action as determined by the Engineer being taken as a result of this evaluation (*24*).

The majority of the respondents indicated they used refereed samples or some form of additional testing to verify which test data would be considered correct. Central laboratories were commonly cited to perform additional testing. Table 5 summarizes the DOT resolution methods.

SUMMARY OF CONTRACT PRACTICES

This chapter examined the various administrative and contract procedures commonly found in DOT specifications that affect acceptance of materials and construction or, in the case of incentives, have an influence on contractor operations.

No legislative barriers to implementing 23 CFR 637 were reported. The survey results indicate that DOTs are not yet using contractor test results in acceptance decisions.

Warranties are being tried on a limited basis. Their main impact appears to be a reduction or elimination of nearly all testing for the work covered by the warranty. Indiana and Wisconsin construction warranties were specific to pavements. Other project work is accepted using traditional procedures.

Qualification or prequalification of contractors on the basis of quality management is not widely performed. Several DOTs indicated they considered quality in their project evaluation process. New Jersey requires a design quality control system from design consultants.

The use of consultants or contractors for inspection testing was typically generated by a lack of personnel in the DOT. The qualifications of testing personnel were relatively consistent for DOT and external consultant personnel. The requirements for contractors were reported as being higher for similar job functions.

Inclusion of quality incentives and disincentives for various test results was common. Smoothness or rideablity was the characteristic most popular for incentive adjustments. The key advantages for including incentives were improved quality, improved contractor concern for quality, and improved smoothness/rideablility. The disadvantages were limited, but some serious concerns regarding the quality of work accepted under incentive clauses were presented.

Regional specifications were not found to be widely employed. DOT aggregate specifications more commonly require regional considerations than other areas in the specifications. Generally, the advantage of the regional specifications was that requirements could be adjusted to reflect locally available materials. The disadvantage was that, because of these materials, the perceived quality was lower.

Two primary strategies for handling materials disputes were noted. The first strategy used additional testing for validation. The additional testing identifies which test was likely to be the correct test result. Other DOTs were satisfied with general statements regarding a need to conduct investigations of the cause (which may include retesting) to simply an administrative determination of the acceptance decision. A number of DOTs do not use contractor testing at this time and, therefore, do not have a dispute resolution technique.

TABLE 5
TEST RESULT DISPUTE RESOLUTION

Resolution Process	Agency
Refereed samples or additional testing required	AL, AZ, CA, FL, MD, ME, MI, MS, NB, NJ, NV, OH, OK, PR, TX, UT, WI
Investigation and administrative decision	AK, AR, IA, IN, ND, NM, MO, WV
None established or in process	CT, GA, HI, IL, LA, MA, MN, NH, PA, RI, SC, TN, VT, WA, WY

CHAPTER FOUR

MANAGEMENT OF TECHNOLOGY

This chapter examines the role that changes in technology or technology management requirements have had on the administration of materials and construction acceptance programs. Laboratory accreditation requirements and increased use of external certifications have been significant changes. Frequency of tests and test tolerance changes, driven by new technology, have also brought changes to acceptance programs. The influence of new materials entering the marketplace, concurrent with reduced test capability in DOTs to independently test all products, is shaping decisions about the requirements for acceptance decisions.

LABORATORY ACCREDITATION

Is your central laboratory AASHTO accredited? If you have other labs, are they AASHTO accredited?

Laboratory accreditation could be a major technology management change for a DOT. In 1988 the American Association of State Highway and Transportation Officials (AASHTO) established the AASHTO Accreditation Program (AAP) to formally recognize the competency of a testing laboratory to perform specific tests on construction materials. The program is available to all laboratories, including independent laboratories, manufacturers' in-house laboratories, university laboratories, and governmental laboratories.

The AASHTO Materials Reference Laboratory (AMRL) is the technical support and administrative group for AAP. Monitoring and administration of AMRL and AAP is assigned to the AASHTO Highway Subcommittee on Materials. AMRL provides laboratory inspection, quality system evaluation and proficiency testing samples for laboratories testing soils, asphalt cements, emulsified asphalts, bituminous concrete, and bituminous concrete aggregates. The Cement and Concrete Reference Laboratory (CCRL) sponsored by the American Society for Testing and Materials (ASTM), for testing hydraulic cement, portland cement concrete (PCC), and PCC aggregates offer similar services. AMRL and CCRL are Research Associate Programs at the National Institute for Standards and Technology (NIST). Appendix D contains a copy of the AASHTO Accreditation Program requirements.

The implementation requirements of 23 CFR 637 state that by June 30, 1997, each DOT shall have its central laboratory accredited by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA. By June 29, 2000, accredited laboratories shall perform all contractor, vendor, and DOT testing used in the acceptance decisions. In September of 1996, only 26 laboratories responding to the survey were AAP facilities. As of October 1997, 46 DOT laboratories have completed portions of the AAP requirements. The data for the October 1997 update are provided in Appendix E.

TESTING

How are the testing and sampling requirements for a project determined? Describe the factors used in making the decision.

Twenty-nine responding DOTs use a predetermined list of sampling frequencies and sample requirements. The key parameters controlling the sampling frequency are the lot size and production for the day. A representative QC/QA Sampling and Testing guideline is provided in Table 6, from the Alabama Department of Transportation QC/QA Requirements for Hot Mix Asphalt Pavements. The test frequencies that depend on lot size will depend on the specific language of the specification. A lot is an isolated quantity of material from a single source or a measured amount of specified construction, which is assumed to be produced by the same process. Each material sampled will have specification directives for lot size.

Historical performance, heuristic (rules-of-thumb), and other approaches are used by a smaller group of DOTs. These methods are suitable in cases where most work is controlled by method specifications, where the test frequency is likely to be a field inspection decision.

The National Cooperative Highway Research Program has sponsored research to investigate testing and inspection levels for hot-mix asphaltic concrete overlays (Project 10-39A). The primary objective of this research is to develop a rational method for determining the minimum level for both agency and contractor testing and inspection activities necessary to satisfactorily construct overlays using existing references from AASHTO. The research is to develop a rational method for determining staffing levels for inspection and testing a specific construction activity. The project is in progress and is anticipated to be completed in 1998.

Have you performed any risk and value assessments or studies on the various tests used for quality assurance?

Only six responses indicated that risk or value assessment is used to evaluate quality assurance tests. Operating characteristic curve analyses and computer simulation tests are used by New Jersey DOT as a risk analysis technique for establishing testing requirements (*25*). New Jersey has a procedure for improving the specification for the compaction level of bituminous materials. Level of compaction was controlled from the air voids content rather than by density control. By controlling air voids, other performance factors affected by air voids, such as permeability, chemical intrusion, oxidation, and creating a hazard from extruded asphalt on the surface due to a low air void content, are addressed by the quality measure. The new plan includes measurement of percent defective, based on the percentage of the lot (4180 m^2 or 5,000 yd^2) falling outside specification limits. The rejectable quality level was set at 75 percent defective. The level was deemed appropriate because of the unlikely event of failure. These features were used to establish the operating characteristic curve (OC). Assignment of these values was based on engineering judgment and historical data on air voids.

The pay factor equation developed for this specification adjusted the pay equation for the cost of needing to place an overlay sooner than expected and an inflation adjustment term. Each of these considerations reflects elements of buyer risk based on future events that are known to occur as the result of accepting lower quality. The new specification was bench-tested against previous project records prior to introduction through pilot projects. Detailed examination of each of the issues involved in a risk analysis approach to quality assurance is beyond the scope of this discussion.

Do you have guidelines for tolerance limits for comparison of test results?

Thirty respondents indicated they do have guidelines for comparison of test results. However, there are two different forms of tolerance limits for test results. The first is for job control decisions, and the second is for comparison of test results from independent samples.

An example of job control by material supply testing is Connecticut's bituminous concrete supply specification. It states that when a producing plant's material does not conform to the job mix formula on three consecutive samples or the master range for two consecutive samples, production shall stop. These rules may also be applied to nonconsecutive samples during any single production day. The tolerance for purposes of cessation of plant production is the difference in any single sample from the job mix formula in excess of the tolerances in Table 7. The plant resumes production after trial mixes have been approved. Tolerances between the job control acceptance tests and the independent quality assurance samples can also be established. The maximum tolerance allowances are used to judge the two independent sets of tests. When the difference in the independent tests falls within the tolerance, the results are considered favorable. Differences in the tests that fall into the unfavorable category require additional

TABLE 6

SAMPLING AND TESTING REQUIREMENTS—ALABAMA

Control Parameter	Sample Size	Sampling Methods	Sampling Location	Testing Methods	ALDOT Testing Frequency	Contractor Testing Frequency
Asphalt content	•	AASHTO T168 & BMTP-210	Loaded truck	BMTP-354 or AASHTO TP53	1 per lot	1 per set of Marshall samples
Maximum specific gravity	•	AASHTO T168 & BMTP-210	Loaded truck	AASHTO T209 (a)	1 per lot	1 per set of Marshall samples
Air void content & VMA and Marshall stability and flow	•	AASHTO T168 & BMTP-210	Loaded truck	BMTP-353 & 307 BMTP 307	1 per lot As needed	1 per set of Marshall samples Marshall stability and flow–1 test per production lot
Retained tensile strength	25 lb (12kg)	AASHTO T168 & BMTP-210	Loaded truck	BMTP-361	1 set of 6 for each test strip(s) and 1 set of 6 for the next 10,000 tons thereafter 1 set of 6 for each additional 20,000 tons or portion thereof	1 set of 6 for each test strip(s) and 1 set of 6 for the next 10,000 tons thereafter 1 set of 6 for each additional 20,000 tons or portion thereof
Mixture gradation & dust to asphalt ratio	•	AASHTO T168 & BMTP-210	Loaded truck	BMTP-371	1 per lot	1 per set of Marshall samples
Mat compaction		BMTP-210	Roadway	BMTP-222 & 350 AASHTO T166	1/2,000 lane feet/lift	1/1,000 lane feet/lift 1/10,000 lane feet/lift
Stockpile gradation	AASHTO T2	AASHTO T2	Stockpile	AASHTO T11 & T27 BMTP-319 & 258		1/1,000 tons/aggregate size

*See BMTP-370 for sample size and other requirements.

TABLE 7

BITUMINOUS CONCRETE TOLERANCES [from Connecticut 4.06.03 1(b) Cessation of Supply]

Criteria	Tolerance ± %
#200	2
#50	4
#30	5
#8	6
#4	7
3/8" and greater	8
Bitumen	0.4

TABLE 8

TEST TOLERANCES EXTRACTED FROM MISSISSIPPI DOT TMD-06-01-00-000M

Hot Asphalt Paving Mixtures	Maximum Variation for Favorable Comparison (%)
Asphalt content by extraction	0.60
Asphalt cement content by nuclear method	0.30
Maximum specific gravity	0.051
Gradation of extracted mineral aggregates (depends on sieve)	2–5

testing or an administrative ruling to determine which tests will be used. Mississippi's allowable split sample differences between the contractor's and the DOT's split sample test results for mixture quality are provided as Table 8.

CERTIFICATIONS

What types of materials and equipment are currently accepted by certifications?

Certifications are a written statement from the supplier that the materials will meet the required specifications. Certificates can be used for manufacturers, fabricators, commercial laboratories, mill test reports, warranties, guarantees, nursery inspections, and others. Certifications are the responsibility of the contractor, who obtains them from the suppliers and provides them to the DOT. Variations or degrees of certification can also be defined.

In Michigan, a Type "A" certification includes a laboratory test report for samples of the lots represented by the certification; a list of all applicable specifications that the material is certified to meet; and a notarized statement. The notarized statement, signed by a responsible representative of the supplier, certifies that the material represented meets all the listed specifications. Examples of materials requiring an "A" certificate include tubing and steel railings, anchor bolts, geotextiles for drainage systems, and extruded aluminum sections. A Type "C" certification is simply a notarized statement, prepared by the manufacturer, certifying that the material in the shipment conforms to the same formula or is essentially the same as material previously approved by the department. Hybrid forms of certification are used when two approved products are incorporated into a single fabricated item. Other DOTs have similar arrangements for types of certifications.

In most cases materials accepted by certification can be sampled and tested on a random basis for the purpose of verifying the certification. Administrative procedures can be used to revoke certification if the materials are found to be defective in some manner. Lists of materials eligible for acceptance by certification are extensive. Appendix F contains a representative sample listing of materials approved by certification.

What advantages or disadvantages has the certification process provided?

The responses to the question on advantages of certification were quite varied, although most responses were related to reduced testing, cost, and personnel. The primary justification for using certifications was economy of time and cost. Given the reductions in staff that have occurred in recent years, certifications may be of greater importance. The following advantages for certification were listed in the survey responses. The numbers in parentheses indicate the number of responses for that specific comment.

Advantages of Certification

- Certifications require less in-house testing (10)
- Certifications reduce costs (6)
- Fewer personnel are required for the project (4)
- They expedite acceptance procedures (3)
- Certifications require less inspection (3)
- A certification can require tests our lab cannot perform (2)
- It places specification responsibility for compliance on the manufacturer or supplier (2)
- The contractor does not have to wait for state to test before using materials (2)
- Certification reduces duplication of (testing) effort and reduces paper work (1)
- Certification allows the DOT to accept materials that historically meet specifications, and focus testing on materials with a lot of variability (1)
- Certifications are easy to accept (1)
- They avoid project and payment delay (1).

Disadvantages of the certification process were more varied than the advantages. Major concerns focus on installation of substandard materials, manufacturer falsification of conformance to specifications, and lack of supplier quality control. The disadvantages reported are as follows:

- It is possible that nonconforming materials are included in the work because of certifications. Failures of certified materials that have been used on many projects will have a widespread impact (5).
- Certifications are accepted at face value, relying on the good faith of the supplier. Success depends on the suppliers' approach to quality, lack of supplier quality assurance (4).

- A manufacturer will certify anything and many do not know the specification requirements. They rubber-stamp test results (4).
- DOT is not prepared to decertify when necessary or they do not have a decertification process (2).
- Certification has created more paperwork (2).
- DOT needs a good QA program to monitor materials, so you know you are getting what you paid for. There is uncertainty of certified products actually meeting specification (2).
- It is difficult to detect noncompliance, and sometimes the product's point of origin is difficult to determine (2).
- Lack of control of quality for certified materials (2).
- Certification may eliminate some competition, if small companies do not supply certification tests due to cost (1).
- Additional monitoring personnel required for certification (1).
- Certification leads to higher frequency of unacceptable materials (1).

It would appear from the list that the major drawback to the certification process is that, other than the certification provided, little is known about the product. The disadvantages clearly point to the importance of performing the random supplier checks and tests. One group of comments relates to the potential for problems when suppliers certify materials not actually meeting the specification. It is apparent that problems may occur if a DOT does not adequately audit certified supplier facilities and their quality programs.

What criteria are used to evaluate suppliers or vendors who wish to become certified suppliers or provide a certified material?

The DOTs use a wide range of procedures to evaluate potential vendors or suppliers of certified materials. Inspection and testing, combined with an on-site inspection, would make the system an ideal auditing process. However, resources are unavailable to perform complete audits of every supplier. Each of the criteria below contributes to an audit process. The number of respondents using a specific procedure is shown in parentheses.

- Inspection and testing by the DOT (7)
- Evaluate vendor QC capability including equipment and personnel (4)
- Compile a product history for consistency in quality (4)
- Conduct on-site inspections or plant visits (2)
- Examine and require product literature (2)
- Require certified test results (2)
- Conduct a panel product review and experimental trial (1)
- Obtain information from other DOTs (1).

How often are on-site inspections of certified suppliers conducted?

While two respondents for evaluation of a potential supplier used only the results of on-site inspections, once approved, the use of on-site inspection increases significantly. Twenty-six respondents visited suppliers on a set frequency or determined the visitation requirements on the basis of the type of product. One respondent indicated they only visited problem vendors. Two DOTs had no guidelines, and only one DOT said they did not perform site visitation. The remaining eleven DOTs in the survey did not provide a response to this question.

Who performs the on-site inspection and testing of certified suppliers?

Responses to this query were consistent with regard to the on-site inspections being carried out by DOT personnel. The specific titles seemed to vary slightly, but personnel performing the inspections were from the DOT's central laboratory materials division.

QUALIFIED PRODUCTS

Do you use qualified products lists?

Unlike certifications, qualified products are those listed specifically by brand name or supplier. The vast majority of the DOTs (34) use qualified or approved product lists. In most cases, the listing implies that the materials can be used without certification, since they have been tested or accepted for use by the DOT using national or state standard procedures. A sample page from Utah's 30-page qualified products list is provided in Appendix F.

Unlike qualified products that have gained acceptance through DOT testing, new products can be evaluated by the Highway Innovative Technology Center (HTEC). HITEC is a collaborative joint venture between the Civil Engineering Research Foundation and FHWA, among others, to evaluate new highway construction products for which standards, tests, or specifications do not exist. HITEC does not generate product specifications. They only publish the results of their testing. Examples of products under evaluation are a gyratory testing machine for asphalt, a water-cement gauge for concrete and new pavement joint dowel bars. In addition to paving materials, HITEC tests materials and systems for bridges, maintenance, and traffic engineering.

Do you use data from the National Transportation Product Evaluation Program (NTPEP) to aid in the determination of placing materials on the qualified product list?

The National Transportation Product Evaluation Program was established by AASHTO in 1994. The program is a pooled resource effort to test materials of common interest among many DOTs. Various manufacturer's products of one type are tested thoroughly by one or two DOTs. The concept of the program is that it will reduce the number of redundant tests performed by each DOT developing their own qualified product list. Unlike HITEC, NTPEP only tests those products that have appropriate AASHTO test protocols and associated standards.

Evaluation results are available for pavement marking materials, plastic drums and flexible delineators, sign sheeting materials, raised pavement markers, and temporary raised pavement markers. Structural steel coatings, joint sealers, and geotextile recommendations are in progress. New panels are being established for changeable message sign and arrow boards, graffiti protection and removal, rapid-setting concrete patch material, and erosion control products. As with HITEC, NTPEP does not accept or reject materials. They provide test or evaluation results to participating departments who can make their own judgment based on the data or perform comparison tests. Twenty-three agencies in the survey reported using NTPEP results, 14 were not using NTPEP, three had no response, and one did not know about the program.

TECHNOLOGY CHANGE

What new inspection, testing equipment, or technology have you adopted in the last five years?

The survey sample reflected the impact of the SHRP Superpave program and related implementation efforts. Twenty-three DOTs reported that they were evaluating some element of the SHRP research results. Four DOTs indicated they were investigating the use of profilometers. Four DOTs were evaluating their QC/QA programs for various types of materials. Some of the more unique technologies being considered are a computerized optical comparator for sieve analysis review and a particle size analyzer for soils and cements (Minnesota), an impact echo device for bridge deck delaminations (Rhode Island), and a laser profiler pipe inspection camera (Georgia). The level of activity suggests that many new technologies will be adopted or introduced in the near future.

How did you implement the change in technology? Do you have a plan in place to implement changes in FHWA or state regulations?

The primary model for change implementation was to simply change the specifications (12 responses) with seven states responding that this is only done after field or laboratory studies. Phased implementation and contractor user group reviews were also reported by several DOTs. The Nebraska DOT has a process plan to implement QC/QA over a 5-year time period. A 'Joint Specifications' committee comprising DOT personnel and contractor representatives was used in West Virginia and Texas. Their specification development is followed by field trials prior to implementation into the permanent specifications. Joint development of specifications ensures the contractors have an opportunity to evaluate and comment on the impact the revision will have on operations. A few states reported not having a planned method of implementation for new technologies.

What motivated the changes?

The range of response to the driving forces of technology change was as diverse as could be expected. Primary causes for change were improved quality (in materials or methods), new technology requirements, changes due to regulation, and more efficient use of resources. Improved quality through implementation of new inspection methods, materials, products, and technology were predominate responses. Reduced costs and better use of manpower from new technology was noted by several states.

Do you have a process by which you verify that personnel using new test equipment or technology have been properly trained in its use?

Technology changes do not occur in a vacuum. New test procedures, equipment, and protocols require training and education. Thirty-three respondents indicated they had a process to verify personnel capability to use test equipment. West Virginia, for example, has a certification-testing program for field use that includes a practical examination and split samples with statistically evaluated independent tests. For laboratories, West Virginia relies on continuous on-the-job training and periodic inspections by CCRL and AMRL. Rhode Island uses an Independent Assurance Testing Unit for field-testing and Proficiency Testing for laboratory personnel to determine when they are properly trained in the use of testing equipment. The responses indicate a fairly high degree of required ability to perform tests either through direct observation of the test procedure or through a comparison test result procedure. The responses to the question were categorized as follows (number of respondents provided in parentheses):

- Observed test performance (20)
- Split sample comparisons (15)
- Proficiency samples (7)
- Round-robin sampling (6)
- Training programs (6)
- Testing certification program (4)
- AMRL and/or CCRL (5)
- Only for AASHTO-accredited test method (1).

SUMMARY OF MANAGEMENT OF TECHNOLOGY CHANGES

The management of the materials and construction acceptance process is influenced by changes in technology as well as technology management requirements. AASHTO accreditation is likely to be the most recent management change influencing the acceptance process. Most DOTs have achieved AAP accreditation requirements.

Tables or charts for determining the appropriate frequency of sampling and testing have been developed within many DOT organizations. Current research is investigating the level of testing needed for asphaltic concrete overlays by the DOT and contractor.

Risk or value assessments are not commonly performed for the materials and construction tests used for quality assurance. For situations in which test comparisons differ, dispute resolution mechanisms were commonly found.

Increasing use of certifications, qualified product lists, and product evaluations by NTPEP and similar organizations will reduce the DOT's need to maintain personnel and equipment to perform a wide range of testing. DOTs are introducing a variety of new equipment and technologies into their QA programs. To qualify personnel on new test systems, DOTs are using more proficiency tests with observers, split sample test result comparisons, or proficiency sampling.

CHAPTER FIVE

MANAGEMENT AND PERSONNEL ISSUES

This chapter focuses on the issues affecting DOTs in their management of personnel for quality assurance and testing. Training requirements and projected workforce trends are important issues confronting DOTs, particularly with rapid changes in technology, personnel qualifications, and reductions in staff.

ACCEPTANCE PROGRAMS

Have you used contractor test results in your construction and materials acceptance program?

Twenty-six respondents indicated they had experiences with contractor test results in the materials acceptance program. From the comments provided, 12 reported good or satisfactory results, four indicated they had mixed (good and poor) results. The remaining responses indicated that the respondents were in the pilot test phase and results were not available yet or that implementation would begin in the 1997 construction season.

Georgia reported mixed results from contractor testing. The DOT experienced good quality with asphaltic concrete and very poor quality with subgrade materials. Nebraska, Arkansas, and Michigan reported satisfactory experiences with contractor testing for asphaltic concretes. The Arizona DOT is experimenting with the use of contractor testing for acceptance purposes as outlined in 23 CFR 637. Arizona DOT reported that the qualification program has assisted in assuring reliable testing within established allowable verification tolerances.

Advantages reported for including contractor test results in acceptance included the following (number of responses in parentheses):

- Places more responsibility/accountability on contractor (9)
- Fewer DOT personnel needed for projects (4)
- Requires less agency testing (2)
- DOT is able to test or have more observation time available for other items. The contractor is like an extension of DOT workforce (2).
- Contractor performing tests results in fewer (or helps reduce) disputes (2).

Disadvantages reported for using contractor tests in acceptance decisions were (each response one time only):

- The contractor test results may be slanted.
- It is difficult to detect falsified data.
- Cannot verify results after they are covered up.
- There is a lack of qualified contractor personnel.
- Process control by contractors results in "knee jerk" solutions to problems instead of evaluating problems using trend analysis.
- Although the contractor is doing the testing, the DOT must remind the contractor [about test requirements] in all phases of testing.
- Contractor test results are not available in a timely manner.

Suspicions about contractor test results, falsified data, and use of loopholes indicate that contract relations may need to be carefully considered when accepting contractor test data. Distrust of the results, on either side, will generate disputes throughout the process. The comments regarding contractor knowledge and qualifications suggest that there is a need to develop better quality management plan requirements and personnel qualifications. Alternatively, when contractors do not have the necessary expertise, qualified firms can be hired to perform the testing and inspection.

Have you used consultants in your construction and materials acceptance program?

Twenty-one responses indicated they had used consultants for construction and materials acceptance. Two DOTs indicated that consultants were only used when the consultant was hired by a contractor. The consultants provided quality control testing for the contractor, and not quality assurance testing for the DOT. The main advantage of using consultants was as an extension to DOT staff. Although many respondents reported that consultants were generally acceptable, they noted several problems with the testing accuracy and timeliness of results. None of the problems with consultants was noted with any significant frequency. Key disadvantages cited were consultant testing inaccuracy, lack of timeliness, poor decisionmaking, inadequate training, and the consultant personnel turnover.

Are you participating in any multi-agency agreements for construction or materials acceptance?

Seventeen DOTs responded that they were using multi-agency agreements. Inspection of coatings or painting and fabrication were the most commonly cited areas where multi-agency agreements were in force. For example, Arkansas reported that Texas and Oklahoma provide inspection of coating procedures at plants in their states that produce epoxy-coated reinforcing steel for Arkansas DOT projects. New England states have adopted a common paint specification. Other DOTs responded that they are considering similar arrangements.

Do you participate in any user [producer] groups or similar arrangements to find common solutions to quality problems?

Many respondents (35) indicated they participated in some form of user-producer groups or councils. Asphalt paving and aggregate production were the most commonly mentioned areas where these groups were organized. The advantages of forming user groups were varied but generally fell into three categories: communication, technical, and economic.

Communication/Education:

- DOT can learn what works or does not work in other states.
- User groups help with improving technology transfer.
- User groups facilitate communication and understanding among all participants.
- The groups help improve the quality of education and training.

Technical:

- All areas of specifications are reviewed.
- More uniform implementation for materials and issues that cross state boundaries.
- User groups provide a check on the inspection process.
- They can keep specifications compatible with industry methods and equipment.

Economic:

- The group can share resources and expertise.
- The resulting specifications satisfy a larger number of companies and DOTs.

The disadvantages of user groups were very limited. One respondent was concerned that producer representatives in such groups had a hidden agenda for their particular constituency. Otherwise, time for and focus of the groups were problems cited.

PERSONNEL QUALIFICATIONS

What specific education, training, and certification requirements do you require for personnel involved in materials and construction acceptance procedures?

The largest group of respondents to this question (15) indicated that they were self-certifying. The methods of self-certification usually included custom training and examination requirements. Some self-certifying DOTs referenced training programs to prepare technicians for NICET examination. Four states clearly indicated NICET certifications were needed as a credential for technicians. Five other responses provided combined qualification requirements.

Arkansas is an example of a self-certifying program. The technician qualification program includes four areas: basic aggregates, soils/earthwork, asphalt plant and field testing, and portland cement concrete testing. Every technician must complete the aggregates qualification requirements before they can be qualified to take other subjects. Each area of qualification has a demonstrated laboratory proficiency requirement and a written test. Technicians are permitted to refer to test method standards during the proficiency examination portion of the qualification. The self-certifying process is an interim program pending development of a formal certification program at the University of Arkansas. Once the university program is started, everyone certified by the existing procedures will retest for qualification under the new program.

The Arkansas aggregates program covers sampling of aggregates, reducing field sample sizes, moisture content, particle size determination, decantation, specific gravity analysis, and deleterious material. The soils program includes sampling, dry soil preparation, particle size determination, moisture content, Atterberg limits, Proctor tests, coarse particle determination, and in-place moisture and density determination. Asphalt plant technicians must cover sampling, asphalt content by nuclear gauge, aggregate wash method, Rice theoretical specific gravity, bulk specific gravity, nuclear density requirements, Marshall method, moisture sensitivity, and moisture content. The portland cement concrete qualifications include sampling freshly mixed concrete, making and curing cylinders, and measuring slump, air content, and unit weight of freshly mixed concrete.

What agencies provide qualification testing or certification that is acceptable for qualifying your technicians or engineers?

The responses to this question identified primary training qualification requirements specified for DOT personnel and contractor personnel. A variety of national, regional, and local programs were identified. The American Concrete Institute (ACI), NICET and professional engineering registrations are all national programs that are frequently specified. Regional training organizations are the next category of responses. For example, the New England states recently formed a joint training and certification program. Pennsylvania, along with other states in the Northeast have a single training source for all bituminous materials. Sources of qualification testing or certification noted by the respondents are listed below. The listing is divided into national and regional/local.

National Programs:

AASHTO Materials Reference Laboratory
American Concrete Institute
American Institute of Steel Construction
American Welding Society
National Asphalt Paving Association
National Institute for Certification in Engineering Technologies
Prestress/Precast Concrete Institute.

Regional/Local Programs:

In-house course development
Local community college programs

New England Technician Training Certification Program (NETTCP)
North East Center for Pavement Technology (PA Bituminous only)
State boards of registration for professional engineers.

FORECASTING PERSONNEL NEEDS

Continuous reduction in staff size, retirements, transfers, and many other factors influence the level of expertise available within DOTs for managing and staffing a materials and construction acceptance process. Expertise needs in specific materials testing and inspection areas must be forecast prior to construction seasons. Where expertise is lacking, consulting firms and testing laboratories may be hired as an extension of the DOT's capability.

Do you anticipate a future loss of technical and engineering expertise to support the quality assurance and acceptance function? In what areas?

Personnel losses have been a major factor in the changes influencing the materials and construction acceptance process. Twenty-two DOTs reported that loss of expertise would continue. The responses were evenly divided regarding where that expertise would be lost. Several believed that their loss would be in field personnel and others projected the loss of specialists in asphaltic concrete or prestressed concrete. Fourteen respondents did not think there would be loss of expertise. Five did not provide a response to the question.

Do you employ manpower management systems to identify possible future shortages or excesses in expertise or skills?

Georgia, New Jersey, Iowa, and Arkansas were the only DOTs reporting systems to forecast manpower needs. North Dakota and Maine are in progress with systems or strategic plans to identify shortages. No indication was provided regarding how these programs were implemented.

New Jersey, for example, conducts a tri-annual projection of staffing needs. The projection is based on active and newly awarded construction during that period, advertising schedules for upcoming work, and proposed construction programs. Additional information is obtained from DOT divisions to support the process. The report details recommended hiring requirements to meet the projected work requirements. The factors considered in the analysis were: restructuring of the Bureau of Materials, contractors performing more asphalt coring, replacements for promotions, and temporary reassignments. Requirements for personnel are based on projections of work effort required for testing, inspection, independent assurance processes, and staff requirements. The tri-annual evaluation is a moving benchmark of projected personnel requirements, enabling the DOT to respond to future needs.

Has your agency drafted a strategy to accommodate changes in staffing expertise?

Alaska, Arkansas, Indiana, Maryland, Wisconsin, and New Jersey responded that they have a strategy in place. Arkansas uses a model crew that is reviewed by a standing committee. Total quality management teams are also used to review staffing changes. Indiana is reviewing what the process will be like in the future when more process control is turned over to the contractor. Maryland is in the implementation process, and Wisconsin is adopting a personnel management plan. Alaska has not implemented its plan. New Jersey prioritizes inspection activities, and as downsizing reduces available inspection staff, lower priority inspections can be changed to certification acceptance with random inspections.

SUMMARY OF MANAGEMENT AND PERSONNEL ISSUES

Management of personnel issues included a variety of subjects. Acceptance programs included discussion of the acceptance of contractor test results, multi-agency agreements, and user-producer groups, which were considered from their staffing requirements. Personnel issues were examined relative to training and certification, anticipated loss of personnel expertise, and manpower forecasting for staffing requirements.

There was generally positive support for the use of contractor testing from the DOTs. The key advantage reported for contractor testing was that it placed more responsibility (accountability for the results) on the contractor. Some suspicions were expressed that focused on how trustworthy contractors will be in providing data to the DOT, although audits, assurance tests, and other resolution methods are available to limit risk.

New and experienced technicians will need to be trained in the latest technologies. Multiple sources of technology training were identified, and several DOTs have responded with local training programs to support national efforts. Multi-agency agreements can help provide regional training. This is a valuable way for DOTs to accomplish their training goals within existing resource constraints. Joint training efforts share resources to develop skilled technicians using the latest technology. Use of national or regional qualification examinations for technicians also reduces the need for one DOT to develop a customized personnel evaluation program.

Only four DOTs have personnel tracking or forecasting systems that would enable them to predict future needs. No significant change in forecasting has occurred in the past decade. Six DOTs have strategies to address changing staff expertise. A gap appears to exist in the planning process, given the rather strong evidence that personnel levels are being reduced. Working with reduced staff emphasizes the importance of ensuring that DOTs can meet personnel needs.

CHAPTER SIX

CONCLUSIONS

The purpose of this synthesis was to examine the literature and current practices related to the management of materials and construction acceptance processes. The wide range of topics covered by this broad scope posed many challenges. Perhaps the most difficult aspect of the synthesis was trying to identify consistent patterns among the DOT practices. Because there were many variations in practices reported for each topic, developing clear patterns or trends was not achieved in many cases. The major factors influencing the management practices were revisions to the FHWA quality assurance regulation, the continued reduction in qualified personnel, and the increasing number of new tests and materials.

The change in the FHWA quality assurance procedures for all Federal-aid highway projects on the National Highway System requires all DOT laboratories to be certified through the AASHTO Accreditation Program. The required qualification impacts laboratory procedures as well as laboratory personnel qualifications. Another influence of this regulation is that it permits DOTs to use contractor test results in the acceptance process. This adds new sampling and testing requirements for contractors and new acceptance concerns for DOTs that adopt this portion of the regulation. The added oversight responsibilities for the DOT should not be ignored, although contractors performing tests may significantly reduce direct sampling and testing requirements for the DOT staff. It should be noted that the number of tests conducted for quality control and acceptance will remain the same or may increase slightly. The new regulation establishes mandatory laboratory certifications and personnel requirements, and outlines the basic quality assurance program for the state DOTs. Nearly all DOT central laboratories have achieved accreditation.

The introduction of new materials, test equipment, and testing protocols has increased the demand for qualified inspectors and laboratory technicians. To reduce the amount of direct DOT testing required for new material acceptance, HITEC, NTPEP, and various other programs are providing preliminary test data on new materials and technology. While these cooperative ventures reduce the need for all DOTs to run duplicate tests for highway material applications, the ultimate decision to use or implement the technology resides with the DOT. It is not known if they will implement new materials and technology without further testing.

The reduction in the number of personnel available for performing materials and construction acceptance is not a recent development. Moreover, many DOTs expect that the general decline in staffing levels will continue in the future. Construction activity in many DOT jurisdictions has not declined proportional to staffing changes. In some instances, construction activity has increased significantly. Increased cooperative training efforts between DOTs, contractors, and suppliers will provide the needed qualifications, provided the personnel can be identified and employed.

The current challenge facing DOT materials and construction administration is to achieve a balance among these factors. The current management techniques and factors influencing testing and acceptance of materials have been considered. The following conclusions are drawn from the literature, materials submitted by DOTs, statements of current practice provided by DOTs, and follow-up interviews for specific information. They are formulated on the basis of their potential for aiding contractors and DOTs in the materials and construction acceptance process.

- *Warranties*—Warranty projects change the fundamental concept of traditional materials and construction acceptance processes. Extended, 5-year or longer, warranties have been tried on a limited basis for pavement materials by a few DOTs. Many other DOTs are watching the results and, if favorable, will likely implement their own warranty construction projects. Pavement performance characteristics, as defined in the current warranties, are the critical elements in formulation of the warranty. Experiences gained in these early efforts need to be documented. Gradual expansion of warranty coverage, to include other elements of construction and longer warranty terms are logical directions to follow. From the materials and construction acceptance management perspective, warranties require the least amount of initial inspection and testing. Time-based inspection, during the warranty period, invokes a new type of inspection, based on aging and condition. These inspections can be integrated with other pavement condition surveys. Thus, pavement condition surveys would need to include testing requirements in addition to general observation surveys.
- *Certifications*—Material certifications, although widely used, are not all the same. Independent laboratory tests are required for some material certifications, while other certifications are merely letters verifying conformance to specification requirements. Improvements in certification audits and increased on-site inspection frequency could help reduce the concerns expressed regarding the potential for acceptance of nonconforming materials with certification. More consistency is needed in the specification of certifications. The audit process and testing requirements for materials should be identified. Without increased uniformity in certification requirements, the doubts about their effectiveness in providing quality assurance will remain.
- *Product Test Lists*—Cooperative testing programs such as HITEC and NTPEP are able to perform baseline testing for the introduction of new materials. HITEC specializes in materials that currently have no established standards or test procedures. NTPEP specializes in testing materials that have

established standards or related AASHTO testing protocols. DOTs can use the national level testing reports from these laboratories as an extension of their testing capabilities. However, in many cases additional testing will be considered necessary due to local conditions.

• *Defining Quality Qualifications*—Maintaining quality of construction with reduced capability to oversee and assure work content is a major DOT challenge. More than ever, the quality of the final project is dependent on three separate contributors. The DOT provides oversight and usually the specifications. In many DOTs, consultant designs are used and quality of design becomes an issue. Finally, the contractor is considered the party responsible for providing quality control and, in limited applications, they will need to provide warranties for their work.

Quality criteria should be satisfied by products submitted by consulting engineers, as demonstrated by the New Jersey DOT. This begins to move traditional quality processes toward the concept of total quality assurance.

In addition, rather than considering contractors qualified on the basis of years of experience and financial capability, qualification should be extended to an evaluation of contractor personnel qualifications and product delivered. The increased administrative demands created by each revision need to be valued against the improvements in quality.

• *Personnel Forecasts*—DOTs are continuously adjusting to changes in staffing requirements, acceptance criteria, acceptance procedures, and reporting requirements. The use of contractors and consultants to extend staff capabilities, accomplishes required testing and inspection, but the practice also generates additional DOT administrative burden during peak periods. Survey responses suggest that the staff reductions should be expected to continue. However, few states are responding to the changing workload requirements with a comprehensive approach to forecasting their personnel needs. Systems that provide personnel management plans that are related to changes in technology and administration requirements are needed.

• *Training*—Personnel training requirements for DOT and contractor personnel are predominately defined in terms of NICET examination qualifications, and in combination with local certification requirements.

Given the trends identified, there are some gaps in the management of materials and construction acceptance that would benefit from further research or investigation. Assuming that DOT personnel levels will not increase, methods that continue to assure quality while they require reduced levels of inspection and decreased testing by the DOT personnel are expected to dominate new developments related to materials and construction acceptance.

• The increased use of warranties on pavements and other elements of construction can be anticipated since little or no inspection and testing are conducted. However, in-depth research and cost-benefit of warranties have not received much focus nationally. Consensus or other rationalization has established 5-year warranties, like the 5 percent incentive payments in specifications. This parameter and others could benefit from additional research. Tests to be employed for warranty inspections, the frequency of inspections, distribution of measurement criteria, and other features of warranties also need closer examination. If other elements of construction are to be included in warranty work, appropriate parameters and measurements will need to be defined for these products.

• Certifications, like warranties, have universal recognition with regard to their defined purpose. However, the certifications themselves are not universal in what they actually represent. A regional or national evaluation on the validity of certifications, and the potential for introduction of noncomplying materials, could be examined. Graded levels of certification would more clearly define the level of assurance necessary for each material. Minimum guidelines could be established for certifications. A certification level, granted by one DOT, should be acceptable by others. The requirements could be extended to evaluation of certification procedures on a regional basis using cooperative agreements and similar concepts.

• Management of the total acceptance process will include quality-based qualification for designers, testing and inspection consultants, and contractors. No longer should services be provided by firms unable to meet acceptable quality levels. Many DOTs require specific qualifications for consultant employees providing inspection and testing services, however the qualification requirements for design deliverables are not well detailed nor are design firm quality control plans. Contractor quality control plans have been specified for some time but the evaluation of contractor quality, as part of the bid qualification process, had not been explored in depth. A national quality certification or regional quality certifications for design and construction could be developed following trends in general manufacturing.

The management of materials and construction acceptance processes will always be a delicate balance of technology, regulatory influences, and contract delivery processes. Many individual issues could have been identified for future research or investigation. Only the larger scope problems have been presented, in keeping with the broad nature of this synthesis.

REFERENCES

1. Final Rule, 23 CRF 637, *Quality Assurance Procedures for Construction,* Federal Register: June 29, 1995 (Volume 60, Number 125, 33712).
2. Tuggle, D.R., FHWA Demonstration Project No. 89, Quality Management and a National Quality Initiative, *Transportation Research Record 1340,* National Research Council, Washington, D.C., 1992, pp. 56-60.
3. Weed, R. M., *Managing Quality: Time for a National Policy,* FHWA/NJ-96-004-7490, Washington, D.C., 1996.
4. Halstead, W.J., NCHRP Synthesis 65: *Quality Assurance*, Transportation Research Board, National Research Council, Washington, D.C., 1979.
5. *Quality Assurance Through Process Control and Acceptance Sampling*, Statistical Quality Control Task Group, Office of Research and Development, U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads, April 1967.
6. Churilla, C.J., "FHWA's Implementation Plan for SHRP Products." *Public Roads*, v. 57, no. 3, Winter 1994, pp. 24–29. (www.iti.nwu.edu/clear/high/pr_w14.html).
7. Chamberlin, W. P., NCHRP Synthesis 212: *Performance-Related Specifications for Highway Construction and Rehabilitation,* Transportation Research Board, National Research Council, National Academy Press, Washington, D.C., 1995.
8. Miller-Warden Associates, NCHRP Report 17: *Development of Guidelines for Practical and Realistic Construction Specifications*, Highway Research Board, Washington, D.C., 1966.
9. Benson, P. E., "Comparison of End Result and Method Specifications for Managing Quality," *Transportation Research Record 1491,* Transportation Research Board, National Research Council, National Academy Press, 1995, pp. 3–10.
10. Elliot, Robert P., Quality Assurance: Top Management's Tool for Construction Quality, *Transportation Research Record 1310,* Transportation Research Board, National Research Council, National Academy Press, 1991, pp. 17–19.
11. Commonwealth of Pennsylvania, Department of Transportation, *Specifications,* (Publication 408) Harrisburg, 1994.
12. McMahon, T.F. and Halstead, W.J. "Quality Assurance in Highway Construction. Part 1—Introduction and Concepts," *Public Roads*, Vol. 35, No. 6, 1968.
13. Weed, R.M., "The proof is in the pavement," *Civil Engineering*, American Society of Civil Engineers, August 1993, pp. 67–69.
14. Hughes, C. S., NCHRP Synthesis 232: *Variability in Highway Pavement Construction*, Transportation Research Board, National Research Council, National Academy Press, 1996, 38 p.
15. Committee on Management of Quality Assurance, Transportation Research Circular, No. 457, *Glossary of Highway Quality Assurance Terms*, Transportation Research Board, National Research Council, April 1996.
16. Hancher, D. E., NCHRP Synthesis 195: *Use of Warranties in Road Construction*, Transportation Research Board, National Research Council, National Academy Press, 1994.
17. Smith, N. L., Jr., NCHRP Synthesis 102: *Material Certification and Material Certification Effectiveness*, Transportation Research Board, National Research Council, National Academy Press, 1983.
18. Collins, B.B., NCHRP Synthesis 120: *Professional Resource Management and Forecasting*, Transportation Research Board, National Research Council, National Academy Press, 1985.
19. Poister, T.H, L.G. Nigro, and R. Bush, NCHRP Synthesis 163: *Innovative Strategies to Upgrade Personnel in State Transportation Departments*, Transportation Research Board, National Research Council, National Academy Press, 1990.
20. Newman, R.B., NCHRP Synthesis 145: *Staffing Considerations In Construction Engineering Management*, Transportation Research Board, National Research Council, 1989.
21. Newman, R. B., NCHRP Synthesis 146: *Use of Consultants for Construction Engineering and Inspection*, Transportation Research Board, National Research Council, National Academy Press, 1989.
22. Federal Aviation Administration, *Advisory Circular*, (AC), 150/5370, Change 7, "Section 100 Contractor Quality Control Program," May 20, 1994.
23. Draft copy, State of New Jersey, *Consultant Quality Assurance Program Plan Guidelines*, Rev. 3, 8/27/96.
24. Weed, R.M., "Composite Pay Equations: General Approach," *Transportation Research Record 1465*, National Research Council, Washington, D.C., 1994, pp. 9–15.
25. Special Provisions Modifying Section 106, Control of Materials, New Mexico State Highway and Transportation Department, January 24, 1996, p. 11.
26. American Association of State Highway Transportation Officials Internet web site: http://www.aashto.org., 12/18/97.

APPENDIX A

23 CFR 637

Federal Register: June 29, 1995 (Volume 60, Number 125, 33712).

Section: Rules and Regulations
Agency: FEDERAL HIGHWAY ADMINISTRATION
Title: Quality Assurance Procedures for Construction
Action: Final rule.

FEDERAL HIGHWAY ADMINISTRATION
DEPARTMENT OF TRANSPORTATION
23 CFR Part 637
[FHWA Docket No. 94-13]
RIN 2125-AD35

Quality Assurance Procedures for Construction

SUMMARY: The FHWA is revising its regulations that establish general requirements for quality assurance procedures for construction on Federal-aid highway projects. The rule provides more flexibility than the existing regulation. The rule allows the use of contractor test results in making the acceptance decision and allows the use of consultants in the independent assurance program and verification sampling and testing. The regulation requires testers and laboratories to be qualified. However, it gives the States the flexibility to establish those qualifications. The revisions will clarify existing policy and procedures and provide additional guidance on the use of contractor-supplied test results in acceptance plans.

EFFECTIVE DATE: July 31, 1995.

FOR FURTHER INFORMATION CONTACT: Mr. Michael Rafalowski, Office of Engineering, HNG-23, 202-366-1571; or Mr. Wilbert Baccus, Office of the Chief Counsel, HCC-32, 202-366-0780; Federal Highway Administration, 400 Seventh Street, SW., Washington, DC 20590. Office hours are 7:45 a.m. to 4:15 p.m., e.t., Monday Through Friday, except Federal holidays.

SUPPLEMENTARY INFORMATION:

Background

The current regulations on sampling and testing of materials and construction appear in 23 CFR Part 637, Construction Inspection and Approval. These regulations were last revised in January 1987. The regulations were written using the concept of the State performing all the sampling and testing, which had been the traditional approach to sampling and testing. The regulations do not address the use of contractor testing.

As a result, a number of questions arose in those States which were using contractor testing in their quality control/ quality assurance (QC/QA) programs.

The existing regulations do not recognize the use of contractor testing results in an acceptance program. An acceptance program is the process of determining whether the materials and workmanship are in reasonably close conformity with the requirements of the approved plans and specifications. In 1992, the FHWA studied the ramifications of using contractor-performed sampling and testing results. The results of its study are reported in "Limits of Use of Contractor Performed Sampling and Testing," dated July 1, 1993. (A copy of the report is available in the docket for inspection and copying.) One of the report's recommendations was that contractor sampling and testing may be used in acceptance programs, provided adequate checks and balances are in place to protect the public investment. The revisions to part 637 made in this final rule would implement the committee's recommendation.

This final rule provides more flexibility to the States in designing their acceptance programs than currently exists. Acceptance of materials and construction will not be based solely on any one set of information. Each State's verification sampling and testing will be used to ensure the quality of the product. In addition, the rule will permit the use of data from the contractors' quality control sampling and testing programs in acceptance programs if the results from the States' verification sampling and testing programs confirm the quality of the material. The verification sampling and testing must be performed on independent samples obtained by the State or designated agent to verify the quality of the material. If the results of a State's verification sampling and testing program do not confirm the quality of the product, a dispute resolution system must be used to determine payment to the contractor.

The requirement for an independent assurance (IA) program will remain in place. The rule will provide the States more flexibility in designing their IA program. The IA program will allow the use of witnessing, split samples, proficiency samples, and equipment calibration as an independent check of the field sampling and testing procedures and equipment to assure that the testing is being performed properly by both the State and the contractor personnel.

Comments to the Docket

A notice of proposed rulemaking (NPRM) was published in the Federal Register on July 12, 1994 (59 FR 35493), in which the FHWA proposed to revise 23 CFR Part 637, Construction Inspection and Approval. A total of 50 commenters responded to the NPRM as follows: 35 State highway agencies, 1 local agency, 1 toll authority, 10 construction industry associations and contractors, and 3 Subcommittees of the American Association of State Highway and Transportation Officials (AASHTO). The major comments and the FHWA's response thereto are summarized as follows.

Supportive of Change

Twenty-six commenters expressed their support for the revisions to the regulation. Fifteen commenters provided comments without indicating support or opposition to the NPRM. The remaining nine commenters were generally opposed to the proposed rule.

Use of Contractor Test Results

Commenters expressed three related concerns over the required system of checks and balances employed when contractor test results are used in the acceptance decision: (1) Requiring the use of independent samples instead of allowing either independent samples or split samples; (2) requiring the use of the F-test and the t-test (which are standard statistical tests for comparing the variances and means of two sets of data) because of the complexity of using the statistical tests; and (3) the perceived duplication of effort between the verification sampling and testing and the testing required by covering the contractor sampling and testing program in the IA program.

The overall intent of the program is to provide adequate assurance that the public is receiving the desired quality in the product produced by the contractor. The first level of assurance is provided by qualifying laboratories and testing personnel. This assures that the equipment and personnel are capable of performing the tests properly. The second level of assurance is provided by the IA program. This level assures that the testers and equipment remain capable of performing the tests properly. The third level of assurance is provided by verification sampling and testing. This level assures the quality of the product.

There appears to have been some misunderstanding of the total level of effort required. The rule as adopted gives the States wide latitude in designing the acceptance program. The system approach to IA assures the capabilities of all equipment and testers regardless of the number of projects or material quantities involved. A broad interpretation of the existing regulations would allow the system approach to IA. However, the final rule explicitly allows the system approach to IA. In those States that are performing a significant amount of testing on split samples and no testing on independent samples, testing on split samples would remain as IA sampling and testing; however, some verification testing on independent samples would be required to confirm the quality of the product. In addition, the verification of the quality of the material can be performed on a mix design or grading of material from a given source and is not limited to project-specific data.

Eleven commenters expressed concern over requiring the use of independent samples for the verification sampling and testing program. The commenters recommended that the use of split samples be permitted for the verification sampling and testing program. The commenters are concerned about the potential problems that may arise with differences in testing results caused by sampling errors.

There are three sources of differences between two test results, differences in the material, differences in test procedures and differences in sampling procedures. Split samples will only address the differences in test procedures and will only provide assurance that the contractor is performing the tests properly. In a balanced system it is also necessary to assure that sampling of materials is performed properly. It is our intent that the verification sampling and testing program be used to independently validate the quality of the material. Using independent samples will insure that all sources of differences are measured. The FHWA recognizes the need to ensure that each contractor performs the tests correctly; that is the reason for extending laboratory and testing personnel qualification requirements and IA program requirements to the contractor if the contractor's test results are to be used in the acceptance decision. The FHWA expects the testing variability between the contractor and the State to be held to a minimum by requiring the contractor's testing program to be covered by an IA program and requiring the testing personnel and laboratories to be qualified. The FHWA has changed the definition of "verification sampling and testing" and Sec. 637.207(a)(1)(ii)(B) to clarify the fact that the verification sampling and testing program is being used to validate the quality of the material.

Eight commenters objected to requiring the use of the F-test and t-test for verifying a contractor's test data. The commenters were concerned about the complexity of the F-test and t-test which would have to be used by field personnel and the lack of flexibility in allowing other comparison systems. The commenters requested that the regulation be revised to allow other types of comparison systems. The FHWA agrees with the concerns and has removed the requirement for a specific comparison procedure. Each State will have the latitude to develop its own verification system.

Three commenters—two State Highway Agencies and one local highway agency--objected to including contractors' testers in States' IA programs. The commenters are concerned over the additional resources involved in extending the IA program to contractor testing.

If a contractor's test results are to be used in the acceptance decision, assurance must be provided that the contractor's testers and equipment remain capable of performing the tests properly. Some States are currently performing split sampling and testing on project sites to validate the contractor's test results. This split sampling and testing would meet the requirements for an IA program on contractor testing. This proposed requirement has been retained in the final rule.

Qualified Sampling and Testing Personnel

Four commenters specifically supported the concept of certifying testing personnel. Two commenters wanted to change the term certified personnel to qualified personnel. The FHWA agrees with the comments since the goal of the FHWA is to have qualified personnel perform the testing. The term "certified" was deleted from the definition of qualified testing personnel.

Sixteen commenters expressed concern about the cost, specific requirements, and/or two-year implementation period for establishing qualification programs for testing personnel. To allow adequate time to develop qualification programs, we have extended the implementation time from two years to five years. If a State chooses to use a certification program as its qualification program, the FHWA is developing training material that can be modified for State use. The FHWA will also assist the States in adapting the material for their use.

Independent Assurance Program

Thirteen commenters objected to the proposal to remove the requirement that State highway agency (SHA) personnel perform IA testing. The States wanted to continue to perform IA testing as a means to maintain expertise in the materials sampling and testing area and maintain the credibility of their materials programs. Since materials sampling and testing are an essential part of determining the quality of the product that is obtained from the use of Federal-aid funds, the FHWA has an interest in maintaining the States' expertise and credibility. However, in cases where States are using contractor test results in acceptance decisions, the FHWA believes it is important that the States have the option of using consultants to perform IA testing. It is important to note that the final rule does not require a SHA to use consultants in the IA program, but simply gives SHAs he option to do so. The FHWA has added Sec. 637.205(b) which requires States to maintain an adequate, qualified staff with the capability of overseeing the entire quality assurance program and specifically requires the States to maintain a central laboratory. This requirement is consistent with 23 U.S.C. 302 which requires each State to maintain an adequate highway department.

Three commenters requested further clarification on the use of the system approach in performing an IA program. The intent of the system approach to the IA program is to concentrate on assuring that the testing personnel and equipment remain capable of performing the tests properly, regardless of the location or number of projects covered by the equipment and tester. The system approach will permit an SHA to fulfill the requirement for an IA program by implementing a schedule of activities to cover equipment operations and tester competence. The activities may include calibration checks, split samples, proficiency samples, and observations. The schedules and type of activity would be based on the test procedure. In the system approach, the frequency of IA may be independent of the number of tests performed or the quantity of material tested. It is envisioned that the system approach will be especially useful in cases where one tester performs testing for more than one project during a construction season. The previous requirement for IA entailed sampling and testing frequencies based on individual project production. In addition, a State may choose to use the information developed from the IA program in the qualification programs for testers and laboratories. One commenter asked if the NPRM would allow a State to use a hybrid approach, which would include some frequencies based on project quantities and frequencies based on the overall system. This rule as written would allow that approach. It should be noted that the rule does not require a State to use this approach.

One commenter wanted the requirements for the IA program to be less stringent. The requirements in the final rule for IA have been made less prescriptive than the current regulations and give a State more latitude in designing its IA system. The existing regulation requires State personnel to perform the IA sampling and testing. The final rule would allow: (1) The use of accredited consultant laboratories in executing an IA program, (2) a system approach instead of a project approach, (3) proficiency samples instead of split samples, and (4) equipment calibration to cover the testing equipment.

Laboratory Qualification

Four commenters supported the proposed requirements for laboratory qualifications.

Eight commenters expressed concerns about the requirements for laboratory qualifications. The NPRM proposed to include by reference two paragraphs from the "Standard Recommended Practice for Establishing and Implementing a Quality System for Construction Testing Laboratories" (R-18) published by the AASHTO in the "Standard Specifications for Transportation Materials and Methods of Sampling and Testing." The commenters believed that R-18 was not appropriate for field laboratories. It was not the FHWA's intent that the entire R-18 standard be used for the qualification of field laboratories. Due to the confusion caused by specifying only a part of R-18, the rule has been revised to specifically list the minimum requirements for field laboratories and delete the reference to R-18.

Eight commenters wanted clarification of the requirements for accreditation of the SHA central laboratory. It is the intent of the FHWA that the accreditation program must meet the guidelines in ASTM E- 994. In addition to the guidelines in ASTM E-994, we have two additional concerns: First, regarding the acceptability of the assessors; and second, concerning the scope of the on-site assessment. For an accreditation program to be acceptable to the FHWA, the assessor must be employees of the accrediting body and not employed by a laboratory which may compete for work with the laboratory being assessed. This would avoid any potential conflicts of interest. In addition, the on-site assessment must include a detailed review of the test procedures in which the laboratory is being accredited. The FHWA believes that only one laboratory accreditation program currently meets the above concerns, and that is the AASHTO Accreditation Program. As we understand the operating procedures of other accreditation programs, they allow reviewers to be employees of other testing laboratories and do not require the laboratory to demonstrate all the tests in which the laboratory is being accredited. If other accreditation programs can satisfy our concerns, we will approve them. Any inquiries or requests for approval should be directed to the FHWA's Office of Engineering.

Six commenters expressed concern about the cost and implementation time necessary for accrediting an SHA central laboratory. The commenters believe that two years is too short a time in which to become accredited. At this time 30 SHAs are accredited by the AASHTO Accreditation Program (AAP). The FHWA contacted the AAP to obtain data on the average length of time required by the AAP to accredit a SHA laboratory after receipt of an application for accreditation. Based on the information supplied by AAP, the FHWA believes that two years is an adequate lead time for obtaining accreditation. The requirement for accreditation replaces the inspections by the National Reference Laboratories which are required by Sec. 637.205 of the current regulation. The actual cost of accreditation to the SHA is the same as the cost of inspection program that it replaces. However, there will be some costs associated with developing the quality system for the initial accreditation for the SHAs. The rule provides flexibility to the SHAs to designate private laboratories to perform independent assurance tests and dispute resolution testing. Since the SHAs must review the qualifications of designated laboratories, the SHAs need to be qualified at the highest level, which is accreditation. Therefore, this final rule maintains the laboratory accreditation requirements as originally proposed.

Definitions

Four commenters suggested changes to the definition of quality control. The definition of quality control was adapted from the definition in ANSI 90 and ISO 9000 which are the industry consensus standards for quality assurance. Therefore, the FHWA is retaining the definition as proposed.

Two commenters wanted to delete the word "accredited" from the definition of "qualified laboratories". There appears to be confusion over the use of the term "accreditation" since the NPRM used the word to describe two different levels of qualifications. The FHWA agrees with the comment because of the apparent confusion. The word "accredited" has been removed from the definition of "qualified laboratories".

Two commenters wanted clarification of the term "vendor". A definition of "vendor" has been added to insure that it includes suppliers of project-produced materials. It was the FHWA's intent that the rule cover only project-produced materials and not manufactured materials.

One commenter suggested changes to the definition of "quality assurance". The definition of "quality assurance" was adapted from the definitions in the ANSI 90 and ISO 9000 standards which are the industry consensus standards for quality assurance. Therefore, the FHWA has retained this definition as proposed in the NPRM.

One commenter suggested requiring random sampling. The FHWA agrees with the comment. In order for test data used in the acceptance decision to be properly analyzed, samples must be obtained on a random basis. Section 637.205(e) has been added to require random sampling. One commenter was concerned with the wording of the definition for IA, which the commenter interpreted as requiring the IA to be performed by a consultant. As stated earlier, it is the FHWA's intent that the States have the option to perform IA sampling and testing themselves or have a qualified designated agent perform the testing. The definition in the final rule has been revised to reflect our intent.

Miscellany

Eight commenters requested a delay in issuing a final rule. Their major concern was over potential conflicts between this final rule and AASHTO's effort to develop guide specifications for Quality Assurance. The AASHTO effort is related to this rulemaking. However, the "AASHTO Quality Assurance Guide Specification" and the "AASHTO Implementation Manual for Quality Assurance" are in the draft stage and are still being reviewed. It may be some time before these documents receive full endorsement by AASHTO. Since the current regulations do not address the practice of using contractor testing in making acceptance decisions, the FHWA believes that it is necessary to proceed with the final rule. The commenters were also concerned that the SHAs did not have adequate time to comment on the regulation. The NPRM provided a 60-day comment period. All comments that were received by the FHWA, including the eleven received after the closing of the comment period, were considered and included in the analysis. In addition, the FHWA received comments from 35 of the 52 SHAs. Therefore, the FHWA believes that adequate time was provided.

Five commenters provided comments on the dispute resolution system. There were comments on both sides of the issue of whether the dispute resolution system should allow third party involvement. Three commenters were in favor of keeping the system in the State; two were in favor of using third parties. In the NPRM the FHWA proposed to permit the SHAs to determine how they wanted to set up the dispute resolution system. The FHWA is aware of cases where a dispute resolution system has worked well in both cases, so this proposal has been retained in the final rule.

Three commenters requested clarification of the terms "acceptance", "verification", and "assurance". This rule requires an acceptance program which includes the establishment of qualifications of testers and laboratories and inspection of construction operations and testing performed by the SHA or its designated agent. Verification sampling and testing is used to validate the quality of the product. Independent assurance is used specifically to insure that the testing is performed correctly and that the equipment is in calibration.

Two commenters provided comments on the materials certificate. One commenter requested that the wording on the material certificate be revised from requiring the materials and operations to be in "conformity with the approved plans and specifications" to "reasonably close conformity to the approved plans and specification." The commenter was concerned about the added work of adding the individual material exceptions to the project
plans and specifications to the materials certificate. The current regulation requires the material certificate to list all materials that do not meet the specifications. The FHWA reserves the right to review the materials certificate to determine if the materials are in conformity with the project plans and specifications. Therefore, the FHWA has retained the wording as proposed in the NPRM. The other commenter wanted to eliminate the requirement for the materials certificate. Section 637.201 limits the rule to projects on the NHS. In addition, Sec. 637.207(a)(3) further limits the requirement for a materials certificate to projects that are subject to FHWA oversight reviews. This will eliminate the requirement for a materials certificate for the vast majority of projects. Since the cost of materials makes up a substantial portion of each project and the information supplied by the materials certificate indicates the quality of the material, it is necessary to have the materials certificate in order to make an informed decision on whether to accept those projects for which the FHWA has retained construction oversight. Therefore, the FHWA has retained the proposed requirement for a materials certificate in this final rule.

One commenter indicated that the cost of implementing the regulation was high and a full regulatory review was needed. As noted below the FHWA has determined that this action is not a significant regulatory action under Executive Order 12366, Regulatory Planning and Review, nor significant under DOT Order 2100.5, Policies and Procedures for Simplification, Analysis, and Review of Regulations, and has concluded that a full regulatory evaluation is not required.

Costs to the States. Currently all States must have approved sampling and testing programs which include an IA program. In addition, all States are required to have their central laboratories inspected by the National Reference Laboratories. As indicated in the fee schedule for the AAP, the actual cost of accreditation itself for the SHAs is the same as the current inspection fees. The additional cost to the States for becoming accredited is in developing the quality assurance manuals which are required by the AAP. The justification for requiring accreditation is stated above. Since the vast majority of States have qualification requirements for their subsidiary laboratories, there would be no additional costs for the States that have these requirements. There would be minimal costs to those States that will have to develop qualification requirements for laboratories. There would be some costs in developing qualifications for testers. One aspect of tester qualifications is attendance at training programs. All States have some training for their technicians, but some of this training may have to be upgraded. However, as stated earlier, the FHWA has a training effort that is available to assist the States in setting up certification programs. The certification programs could be used in the States' establishment of tester qualifications.

Costs to the public. There would be no additional costs to the industry if a State chooses not to incorporate contractor tests into the acceptance system. If a State chooses to use contractor tests in acceptance decisions, contractors would be required to hire employees qualified in the appropriate tests and the State would be required to ensure that the contractors maintain a qualified laboratory or hire a qualified laboratory to perform the testing. When a State uses contractor quality control testing results in the acceptance decision, testing performed by the State is reduced. This reduction in testing by the State reduces the overhead costs in the State. However, any additional cost the contractors incur in performing the testing, including costs of obtaining qualified laboratories and testers, will be passed onto the State through higher bid prices. The cost savings by the State due to the reduction of testing by State personnel would be offset by the increase in bid prices charged by the Contractors. As a result, the FHWA believes that the additional costs of these actions would be minimal.

One commenter was concerned because its Quality Assurance program is located in several documents and it did not want to consolidate the information into one document. The FHWA does not see the need for all the documentation of a State's Quality Assurance program to be in one document.

One commenter interpreted the NPRM to propose a requirement for a central laboratory and the commenter opposed such a requirement. The NPRM did not expressly propose to require a central laboratory; however, the NPRM did propose to require that each State's central laboratory be accredited by the AAP or a comparable program approved by the FHWA. For the reasons stated above, this final rule now requires a central laboratory.

One commenter was concerned about the effect of these QC/QA regulations on small projects. As indicated in the preamble of the NPRM, it is not the intent of the FHWA in this regulation to require the use of contractor testing in the acceptance decision. In addition, the rule expressly covers only projects on the National Highway system (NHS); projects not on the NHS can use other SHA procedures to accept materials. It is anticipated that the majority of small projects will not be on the NHS.

One commenter was against QC/QA procedures. The rule does not require SHAs to use statistical concepts or to use contractor-supplied test results in the acceptance decision. However, the rule does establish minimum requirements if an SHA chooses to use contractor test results in the acceptance decision.

One commenter suggested a revision to the portion of Sec. 637.207 concerning inspection to reflect the positive as well as the negative aspects of the quality of the product or construction. The section in the NPRM read, "The SHA shall inspect the product or construction or both for attributes that are detrimental to the performance of the finished product." The FHWA agrees with the comment. Section 637.207(a)(1)(i)(C) has been revised to reflect both beneficial and negative aspects of the quality of the finished product.

One commenter indicated that the regulation was too prescriptive. The rule, however, provides more flexibility than the existing regulation. The rule allows the use of contractor test results in making the acceptance decision and allows the use of consultants in the independent assurance program. Neither of these were allowed by the existing regulations. The regulation requires testers and laboratories to be qualified. However, it gives the States the flexibility to establish those qualifications. In addition, the final rule modified Section 637.207 to remove the requirement for a specific comparison procedure to validate the quality of the material. The rule clarifies existing policy and procedures and provides additional guidance on the use of contractor-supplied test results in acceptance plans.

One commenter questioned the title and purpose of the proposed rule, indicating that the rule covers materials and not construction. Over 50 percent of the cost of construction is the cost of the material. In addition, the rule requires each State to inspect construction to insure that the construction procedures do not adversely affect the properties of the material. Therefore, the title of this rule remains unchanged. Executive Order 12866 (Regulatory Planning and Review) and DOT Regulatory Policies and Procedures. The FHWA has determined that this action is not a significant regulatory action within the meaning of Executive Order 12866 or significant within the meaning of Department of Transportation's regulatory policies and procedures. The FHWA, at 23 CFR 637, currently has regulations covering sampling and testing. The rule provides the States with additional flexibility in comparison to the current regulations. States will be allowed to use contractor test results in making acceptance decisions and consultants to perform independent assurance testing. Other changes update the current regulations to accommodate contractor-performed sampling and testing and reinforce existing policy. Therefore, it is anticipated that the economic impact of this rulemaking will be minimal and a full regulatory evaluation is not required.

Regulatory Flexibility Act

In compliance with the Regulatory Flexibility Act (5 U.S.C. 601- 612), the FHWA has evaluated the effects of this action on small entities. The FHWA concluded that this action may provide some small testing firms with an opportunity to perform more work than was allowed by the previous regulations. Although the regulation will have a positive impact on these testing firms, the number of firms affected will be small and the amount of additional work would be insignificant. Therefore, the FHWA hereby certifies that this rulemaking will not have a significant economic impact on a substantial number of small entities. Executive Order 12612 (Federalism Assessment).

This action has been analyzed in accordance with the principles and criteria contained in Executive Order 12612. The rule provides the States with additional flexibility over the current regulations. States will be allowed to use contractor test results in making acceptance decisions and consultants to perform IA testing. Therefore, it has been determined that this action does not have sufficient federalism implications to warrant the preparation of a separate federalism assessment.

Executive Order 12372 (Intergovernmental Review)

Catalog of Federal Domestic Assistance Program Number 20.205, Highway Planning and Construction. The regulations implementing Executive Order 12372 regarding intergovernmental consultation on Federal programs and activities apply to this program.

Paperwork Reduction Act

This action does not contain a collection of information requirement for purposes of the Paperwork Reduction Act of 1980, 44 U.S.C. 3501-3520.

National Environmental Policy Act

This rulemaking does not have any effect on the environment. It does not constitute a major action having a significant effect on the environment, and therefore does not require the preparation of an environmental impact statement pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.)

Regulation Identification Number

A regulation identification number (RIN) is assigned to each regulatory action listed in the Unified Agenda of Federal Regulations. The Regulatory Information Service Center publishes the Unified Agenda in April and October of each year. The RIN contained in the heading of this document can be used to cross reference this action with the Unified Agenda.

List of Subjects in 23 CFR Part 637

Grant programs—transportation, Highways and roads, Quality assurance,
Materials sampling and testing.
Issued on: June 22, 1995.
Rodney E. Slater,
Federal Highway Administrator
In consideration of the foregoing, the FHWA is amending title 23, Code of Federal Regulations, by revising part 637 to read as follows:

PART 637--CONSTRUCTION INSPECTION AND APPROVAL
Subpart A--[Reserved]
Subpart B--Quality Assurance Procedures for Construction
Sec.
637.201 Purpose.
637.203 Definitions.
637.205 Policy.
637.207 Quality assurance program.
637.209 Laboratory and sampling and testing personnel qualifications.
Appendix A to Subpart B--Guide Letter of Certification by State Engineer
Authority: 23 U.S.C. 109, 114, and 315; 49 CFR 1.48(b).
Subpart A--[Reserved]
Subpart B--Quality Assurance Procedures for Construction
Sec. 637.201 Purpose.
To prescribe policies, procedures, and guidelines to assure the quality of materials and construction in all Federal-aid highway projects on the National Highway System.

Sec. 637.203 Definitions

Acceptance program. All factors that comprise the State highway agency's (SHA) determination of the quality of the product as specified in the contract requirements. These factors include verification sampling, testing, and inspection and may include results of quality control sampling and testing.

Independent assurance program. Activities that are an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program. Test procedures used in the acceptance program which are performed in the SHA's central laboratory would not be covered by an independent assurance program.

Proficiency samples. Homogeneous samples that are distributed and tested by two or more laboratories. The test results are compared to assure that the laboratories are obtaining the same results.

Qualified laboratories. Laboratories that are capable as defined by appropriate programs established by each SHA. As a minimum, the qualification program shall include provisions for checking test equipment and the laboratory shall keep records of calibration checks.

Qualified sampling and testing personnel. Personnel who are capable as defined by appropriate programs established by each SHA.

Quality assurance. All those planned and systematic actions necessary to provide confidence that a product or service will satisfy given requirements for quality.

Quality control. All contractor/vendor operational techniques and activities that are performed or conducted to fulfill the contract requirements.

Random sample. A sample drawn from a lot in which each increment in the lot has an equal probability of being chosen.

Vendor. A supplier of project-produced material that is not the contractor.

Verification sampling and testing. Sampling and testing performed to validate the quality of the product.

Sec. 637.205 Policy

(a) Quality assurance program. Each SHA shall develop a quality assurance program which will assure that the materials and workmanship incorporated into each Federal-aid highway construction project on the NHS are in conformity with the requirements of the approved plans and specifications, including approved changes. The program must meet the criteria in Sec. 637.207 and be approved by the FHWA.

(b) SHA capabilities. The SHA shall maintain an adequate, qualified staff to administer its quality assurance program. The State shall also maintain a central laboratory. The State's central laboratory shall meet the requirements in Sec. 637.209(a)(2).

(c) Independent assurance program. Independent assurance samples and tests or other procedures shall be performed by qualified sampling and testing personnel employed by the SHA or its designated agent.

(d) Verification sampling and testing. The verification sampling and testing are to be performed by qualified testing personnel employed by the SHA or its designated agent, excluding the contractor and vendor.

(e) Random samples. All samples used for quality control and verification sampling and testing shall be random samples.

Sec. 637.207 Quality assurance program

(a) Each SHA's quality assurance program shall provide for an acceptance program and an independent assurance (IA) program consisting of the following:
(1) Acceptance program.
(i) Each SHA's acceptance program shall consist of the following:
(A) Frequency guide schedules for verification sampling and testing which will give general guidance to personnel responsible for the program and allow adaptation to specific project conditions and needs.
(B) Identification of the specific location in the construction or production operation at which verification sampling and testing is to be accomplished.
(C) Identification of the specific attributes to be inspected which reflect the quality of the finished product.
(ii) Quality control sampling and testing results may be used as part of the acceptance decision provided that:
(A) The sampling and testing has been performed by qualified laboratories and qualified sampling and testing personnel.
(B) The quality of the material has been validated by the verification sampling and testing. The verification testing shall be performed on samples that are taken independently of the quality control samples.
(C) The quality control sampling and testing is evaluated by an IA program.
(iii) If the results from the quality control sampling and testing are used in the acceptance program, the SHA shall establish a dispute resolution system. The dispute resolution system shall address the resolution of discrepancies occurring between the verification sampling and testing and the quality control sampling and testing. The dispute resolution system may be administered entirely within the SHA.
(2) The IA program shall evaluate the qualified sampling and testing personnel and the testing equipment. The program shall cover sampling procedures, testing procedures, and testing equipment. Each IA program shall include a schedule of frequency for IA evaluation. The schedule may be established based on either a project basis or a system basis. The frequency can be based on either a unit of production or on a unit of time.
(i) The testing equipment shall be evaluated by using one or more of the following: Calibration checks, split samples, or proficiency samples.
(ii) Testing personnel shall be evaluated by observations and split samples or proficiency samples.
(iii) A prompt comparison and documentation shall be made of test results obtained by the tester being evaluated and the IA tester. The SHA shall develop guidelines including tolerance limits for the comparison of test results.
(iv) If the SHA uses the system approach to the IA program, the SHA shall provide an annual report to the FHWA summarizing the results of the IA program.
(3) The preparation of a materials certification, conforming in substance to Appendix A of this subpart, shall be submitted to the FHWA Division Administrator for each construction project which is subject to FHWA construction oversight activities.
(b) [Reserved]

Sec. 637.209 Laboratory and sampling and testing personnel qualifications

(a) Laboratories.
(1) After June 29, 2000, all contractor, vendor, and SHA testing used in the acceptance decision shall be performed by qualified laboratories.
(2) After June 30, 1997, each SHA shall have its central laboratory accredited by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA.
(3) After June 29, 2000, any non-SHA designated laboratory which performs IA sampling and testing shall be accredited in the testing to be performed by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA.
(4) After June 29, 2000, any non-SHA laboratory that is used in dispute resolution sampling and testing shall be accredited in the testing to be performed by the AASHTO Accreditation Program or a comparable laboratory accreditation program approved by the FHWA.
(b) Sampling and testing personnel. After June 29, 2000, all sampling and testing data to be used in the acceptance decision or the IA program shall be executed by qualified sampling and testing personnel.
(c) Conflict of interest. In order to avoid an appearance of a conflict of interest, any qualified non-SHA laboratory shall perform only one of the following types of testing on the same project: Verification testing, quality control testing, IA testing, or dispute resolution testing.

Appendix A to Subpart B—Guide Letter of Certification by State Engineer

Date
Project No.
This is to certify that:

The results of the tests used in the acceptance program indicate that the materials incorporated in the construction work, and the construction operations controlled by sampling and testing, were in conformity with the approved plans and specifications. (The following sentence should be added if the IA testing frequencies are based on project quantities. All independent assurance samples and tests are within tolerance limits of the samples and tests that are used in the acceptance program.)

Exceptions to the plans and specifications are explained on the back hereof (or on attached sheet).
Director of SHA Laboratory or other appropriate SHA Official.
[FR Doc. 95-15932 Filed 6-28-95; 8:45 am]
BILLING CODE 4910-22-P

APPENDIX B

Survey

NCHRP SYNTHESIS 27-05

METHODS FOR STATE CONSTRUCTION AND MATERIALS ACCEPTANCE QUESTIONNAIRE

Agency: ______________________________

Address: ______________________________

City: ________________ State/Prov: __________ ZIP: __________

Questionnaire Completed By: ______________________________

Position/Title: ______________________________

Date: ______________________

In case of questions please provide:

Telephone: ( ) ____________ Fax: ( ) ____________

PURPOSE OF THIS SURVEY

Many state highway agencies have been faced with decreasing resources to support quality assurance and monitoring activities. The FHWA "Quality Assurance Procedures for Construction" (23 CFR 637, Federal Register, Volume 60, Number 125, 33712, June 29, 1995) allows the use of contractor test results in making the acceptance decision and allows the use of consultants in the independent assurance program and verification sampling and testing. The regulations further require that testers and laboratories be qualified, and that qualifications are to be established by the States.

"A synthesis of practice is needed to describe the current management techniques and approaches to inspection and testing of materials and construction." Innovative strategies in the assurance of quality construction and the advantages and disadvantages of various practices are sought. Furthermore, as the use of consultants and contractors expands, the issues regarding agency personnel skills and expertise become increasingly important.

RETURN QUESTIONNAIRE AND SUPPORTING DOCUMENTS BY:

TO: Gary R. Smith
Penn State University
212 Sackett Building
University Park, PA, 16802
Day: 814–863–2934 FAX: 814–863–7304

Please write on back if you need additional space for your response.
Section 1 Contract Practices and Regulations

1. Do you know of any State legislation or other restrictions that would prevent your agency from use of contractor's test results or consultant testing for assurance as established by the guidelines in 23 CFR 637? __YES __NO (Note: A copy of 23 CFR 637 is attached to the end of this survey.) Comments:

2. Does your agency incorporate warranties in the construction acceptance process?
___Yes ___NO

If your response was YES, how have warranties affected the role of inspection and testing?

If your response was NO, do you plan to implement warranties: ___YES ___NO
Will you change your acceptance and testing requirements as a result of adopting warranties? YES ___NO If yes, what changes will be made?

3. Do you evaluate contractor quality control systems as part of the prequalification process for bidding on projects? YES ___NO
If yes, what quality related criteria are considered in the contractor prequalification process?

4. Do you contract with any "outside" agencies to provide quality assurance or acceptance testing? ___YES ___NO If yes, please respond to the following:

   a. What creates the need for your agency to contract quality assurance and acceptance testing outside the agency?

   b. What would you describe as the advantages of using outside agencies in quality assurance or quality control testing?

   c. What would you describe as the disadvantages of using outside agencies in quality assurance or quality control testing?

   d. Please provide a copy of the qualification requirements established for these outside agencies.

5. Are quality incentives and disincentives used in your specifications? ___YES ___NO If yes, which specification sections use incentives and disincentives? Please list the specific section and describe or provide a copy of the appropriate section.

What advantages and disadvantages have been expressed regarding incentive and disincentives related to quality (i.e., smoothness index limits).

6. Do you use regionalized specifications which tailor specific clauses for materials or acceptance due to local material availability or practices? ___YES ___NO

If yes, are your specifications regionalized with the __ state or __ among adjacent states?
Please list the types of materials or practices which are regionalized:

What are the advantages and disadvantages of using regionalized specifications?

7. Do you have a dispute resolution mechanism in your quality assurance program for instances when assurance tests do not agree with consultant or contractor test results? YES ___NO

Please provide a copy of the resolution process or describe the process.

SECTION 2 Technological Changes

1. Materials Acceptance Programs

a. What types of materials and equipment are currently accepted by certification?

b. What advantages or disadvantages has the certification process provided?

c. Do you use qualified products lists (QPL)? ___YES ___NO

d. What criteria are used to evaluate suppliers or vendors who wish to become certified suppliers or provide a certified material?

e. Do you use data from the National Transportation Product Evaluation Program (NTPEP) to aid in the determination of placing products on the qualified products list? ___YES ___NO

f. How often are on-site inspections of certified suppliers conducted?

g. Who performs the on-site inspection and testing of certified suppliers?

2. How are testing and sampling requirements for a project determined? Describe the factors used in making the decision. If the analysis is formally documented, copies of the procedure would be appreciated.

3. Have you performed any risk and value assessments or studies on the various tests used for quality assurance or acceptance testing: ___YES ___NO

If yes, please provide an indication where a copy of studies may be obtained or a contact name and phone number to discuss study findings.

NAME: ______

TITLE: ______

ADDRESS: ______

CITY: ______ STATE/PROV: ______ ZIP: ______

PHONE: ______ FAX ______

4. What new inspection, testing equipment or technology have you adopted in the last 5 years?

a. Please list

b. How did you implement the change in technology? Do you have a plan in place to implement changes in FHWA or state regulations?

c. What motivated the changes?

5. a. Is your central laboratory AASHTO Accredited ___YES ___NO
b. If you have other labs, are they AASHTO Accredited? ___YES ___NO

6. Do you have a process by which you verify that personnel using new test equipment or technology have been properly trained in its use? ___YES ___NO Please describe the verification procedures (observation, split sampling, proficiency samples):

7. Do you have guidelines for tolerance limits for comparison of test results? ___YES ___NO

SECTION 3 General Management Issues

1. Have you used contract test results in your construction and materials acceptance program? ___YES ___NO
If yes, what were your experiences with the contractor's testing, personnel, and reported data?

What advantages did the process provide?

What disadvantages did the process provide?

2. Have you used consultants for acceptance testing in your construction and materials acceptance program? ___YES ___NO
If yes, what were your experiences with the contractor's testing, personnel, and reported data? (Training, accuracy, timeliness, etc.)

What advantages did the process provide?

What disadvantages did the process provide?

3. Are you participating in any multi-agency agreements for construction or materials acceptance. ___YES ___NO If yes, please specify type of agreement and agency.

4. Do you participate in any user groups or similar arrangements to find common solutions to quality problems? ___YES ___NO if yes, please describe the general objectives of the group and the accomplishments or goals.

4. (Continued) What advantages or disadvantages have you encountered with user groups?

5. What specific education, training, and certification requirements do you require for personnel involved in materials and construction acceptance procedures?

SECTION 4 Personnel Management (This section may be filled out by Personnel Management Division)

1. What technical agencies provide qualification testing or certification that is acceptable for your technicians or engineers?

2. Do you have minimum qualifications of personnel engaged in the quality control and quality assurance of projects?

3. Do you anticipate a future loss of technician and engineering expertise to support the quality assurance and acceptance function?
___YES ___NO
If you answered yes, in what areas do you anticipate losing quality assurance or testing expertise?

4. Do you employ manpower management systems to identify possible future shortages or excesses in expertise or skills?
YES ___NO
If yes, could you provide an example of the report generated that identifies the shortage.

If no, how are decisions made relative to hiring qualified personnel in appropriate areas of expertise?

5. Has your agency drafted a strategy to accommodate changes in staffing expertise?
___YES ___NO

If yes, has this strategy been implemented, how successful has it been and what problems were encountered?

SECTION 5 General Response

Do you use any new or innovative management techniques or approaches to inspection, testing, or quality assurance for construction? Please describe what you feel are your most innovative solutions and the advantages or disadvantages the new approach has provided.

APPENDIX C

FAA Quality Control Program

SECTION 100
CONTRACTOR QUALITY CONTROL PROGRAM

100-01 GENERAL

When the specifications require a Contractor Quality Control Program, the Contractor shall establish, provide, and maintain an effective Quality Control Program that details the methods and procedures that will be taken to assure that all materials and completed construction conform to contract plans, technical specifications and other requirements, whether manufactured by the Contractor, or procured from subcontractors or vendors. Although guidelines are established and certain minimum requirements are specified herein and elsewhere in the contract technical specifications, the Contractor shall assume full responsibility for accomplishing the stated purpose.

The intent of this section is to enable the Contractor to establish a necessary level of control that will:

a. Adequately provide for the production of acceptable quality materials.
b. Provide sufficient information to assure both the Contractor and the Engineer that the specification requirements can be met.
c. Allow the Contractor as much latitude as possible to develop his or her own standard of control.

The Contractor shall be prepared to discuss and present, at the preconstruction conference, his/her understanding of the quality control requirements. The Contractor shall not begin any construction or production of materials to be incorporated into the completed work until the Quality Control Program has been reviewed by the Engineer. No partial payment will be made for materials subject to specific quality control requirements until the Quality Control Program has been reviewed.

The quality control requirements contained in this section and elsewhere in the contract technical specifications are in addition to and separate from the acceptance testing requirements. Acceptance testing requirements are the responsibility of the Engineer.

100-02 DESCRIPTION OF PROGRAM

a. General Description. The Contractor shall establish a Quality Control Program to perform inspection and testing of all items of work required by the technical specifications, including those performed by subcontractors. This Quality Control Program shall ensure conformance to applicable specifications and plans with respect to materials, workmanship, construction, finish, and functional performance. The Quality Control Program shall be effective for control of all construction work performed under this Contract and shall specifically include surveillance and tests required by the technical specifications, in addition to other requirements of this section and any other activities deemed necessary by the Contractor to establish an effective level of quality control.

b. Quality Control Program. The Contractor shall describe the Quality Control Program in a written document which shall be reviewed by the Engineer prior to the start of any production, construction, or off-site fabrication. The written Quality Control Program shall be submitted to the Engineer for review at least [ ] calendar days before the [ ].

****

The Engineer should choose an adequate period for review. A minimum of 5 days before the preconstruction conference or the start of work is recommended.

Submittal of the written Quality Control Program prior to the preconstruction conference will allow the Engineer to review the contents and make suggestions at the preconstruction meeting.

> Submittal of the written Quality Control Program prior to the start of work will allow for detailed discussion of the requirements at the preconstruction meeting. This will give the Contractor a better understanding of the requirements before developing the Quality Control Program.

****

The Quality Control Program shall be organized to address, as a minimum, the following items:

a) Quality control organization;
b) Project progress schedule;
c) Submittals schedule;
d) Inspection requirements;
e) Quality control testing plan;
f) Documentation of quality control activities; and
g) Requirements for corrective action when quality control and/or acceptance criteria are not met.

The Contractor is encouraged to add any additional elements to the Quality Control Program that he/she deems necessary to adequately control all production and/or construction processes required by this contract.

100-03 QUALITY CONTROL ORGANIZATION

The Contractor's Quality Control Program shall be implemented by the establishment of a separate quality control organization. An organizational chart shall be developed to show all quality control personnel and how these personnel integrate with other management/production and construction functions and personnel.

The organizational chart shall identify all quality control staff by name and function, and shall indicate the total staff required to implement all elements of the Quality Control Program, including inspection and testing for each item of work. If necessary, different technicians can be utilized for specific inspection and testing functions for different items of work. If an outside organization or independent testing laboratory is used for implementation of all or part of the Quality Control Program, the personnel assigned shall be subject to the qualification requirements of paragraph 100-03a and 100-03b. The organizational chart shall indicate which personnel are Contractor employees and which are provided by an outside organization.

The quality control organization shall consist of the following minimum personnel:

a. Program Administrator. The Program Administrator shall be a full-time employee of the Contractor, or a consultant engaged by the Contractor. The Program Administrator shall have a minimum of 5 years of experience in airport and/or highway construction and shall have had prior quality control experience on a project of comparable size and scope as the contract.

Additional qualifications for the Program Administrator shall include at least 1 of the following requirements:

1) Professional engineer with 1 year of airport paving experience acceptable to the Engineer.
2) Engineer-in-training with 2 years of airport paving experience acceptable to the Engineer.
3) An individual with 3 years of highway and/or airport paving experience acceptable to the Engineer, with a Bachelor of Science Degree in Civil Engineering, Civil Engineering Technology or Construction.
4) Construction materials technician certified at Level III by the National Institute for Certification in Engineering Technologies (NICET).
5) Highway materials technician certified at Level III by NICET.
6) Highway construction technician certified at Level III by NICET.
7) A NICET certified engineering technician in Civil Engineering Technology with 5 years of highway and/or airport paving experience acceptable to the Engineer.

The Program Administrator shall have full authority to institute any and all actions necessary for the successful implementation of the Quality Control Program to ensure compliance with the contract plans and technical specifications. The Program Administrator shall report directly to a responsible officer of the construction firm. The Program Administrator may supervise the Quality Control Program on more than one project provided that person can be at the job site within 2 hours after being notified of a problem.

* *

If, in the opinion of the Engineer, the project is of sufficient scope and size to warrant a full time, on-site Program Administrator, paragraph 100-03a should be modified accordingly.

* *

b. Quality Control Technicians. A sufficient number of quality control technicians necessary to adequately implement the Quality Control Program shall be provided. These personnel shall be either engineers, engineering technicians, or experienced craftsman with qualifications in the appropriate field equivalent to NICET Level II or higher construction materials technician or highway construction technician and shall have a minimum of 2 years of experience in their area of expertise.

The quality control technicians shall report directly to the Program Administrator and shall perform the following functions:

1. Inspection of all materials, construction, plant, and equipment for conformance to the technical specifications, and as required by Section 100-06.
2. Performance of all quality control tests as required by the technical specifications and Section 100-07.

Certification at an equivalent level, by a state or nationally recognized organization will be acceptable in lieu of NICET certification.

c. Staffing Levels. The Contractor shall provide sufficient qualified quality control personnel to monitor each work activity at all times. Where material is being produced in a plant for incorporation into the work, separate plant and field technicians shall be provided at each plant and field placement location. The scheduling and coordinating of all inspection and testing must match the type and pace of work activity. The Quality Control Program shall state where different technicians will be required for different work elements.

100-04 PROJECT PROGRESS SCHEDULE

The Contractor shall submit a coordinated construction schedule for all work activities. The schedule shall be prepared as a network diagram in Critical Path Method (CPM), PERT, or other format, or as otherwise specified in the contract. As a minimum, it shall provide information on the sequence of work activities, milestone dates, and activity duration.

The Contractor shall maintain the work schedule and provide an update and analysis of the progress schedule on a twice monthly basis, or as otherwise specified in the contract. Submission of the work schedule shall not relieve the Contractor of overall responsibility for scheduling, sequencing, and coordinating all work to comply with the requirements of the contract.

100-05 SUBMITTALS SCHEDULE

The Contractor shall submit a detailed listing of all submittals (e.g., mix designs, material certifications) and shop drawings required by the technical specifications. The listing can be developed in a spreadsheet format and shall include:

a) Specification item number;
b) Item description;
c) Description of submittal;
d) Specification paragraph requiring submittal; and
e) Scheduled date of submittal.

100-06 INSPECTION REQUIREMENTS

Quality control inspection functions shall be organized to provide inspections for all definable features of work, as detailed below. All inspections shall be documented by the Contractor as specified by Section 100-07.

Inspections shall be performed daily to ensure continuing compliance with contract requirements until completion of the particular feature of work. These shall include the following minimum requirements:

a. During plant operation for material production, quality control test results and periodic inspections shall be utilized to ensure the quality of aggregates and other mix components, and to adjust and control mix proportioning to meet the approved mix design and other requirements of the technical specifications. All equipment utilized in proportioning and mixing shall be inspected to ensure its proper operating condition. The Quality Control Program shall detail how these and other quality control functions will be accomplished and utilized.

b. During field operations, quality control test results and periodic inspections shall be utilized to ensure the quality of all materials and workmanship. All equipment utilized in placing, finishing, and compacting shall be inspected to ensure its proper operating condition and to ensure that all such operations are in conformance to the technical specifications and are within the plan dimensions, lines, grades, and tolerances specified. The Program shall document how these and other quality control functions will be accomplished and utilized.

100-07 QUALITY CONTROL TESTING PLAN

As a part of the overall Quality Control Program, the Contractor shall implement a quality control testing plan, as required by the technical specifications. The testing plan shall include the minimum tests and test frequencies required by each technical specification Item, as well as any additional quality control tests that the Contractor deems necessary to adequately control production and/or construction processes.

The testing plan can be developed in a spreadsheet fashion and shall, as a minimum, include the following:

a) Specification item number (e.g., P-401);
b) Item description (e.g., Plant Mix Bituminous Pavements);
c) Test type (e.g., gradation, grade, asphalt content);
d) Test standard (e.g., ASTM or AASHTO test number, as applicable);
e) Test frequency (e.g., as required by technical specifications or minimum frequency when requirements are not stated);
f) Responsibility (e.g., plant technician); and
g) Control requirements (e.g., target, permissible deviations).

The testing plan shall contain a statistically-based procedure of random sampling for acquiring test samples in accordance with ASTM D 3665. The Engineer shall be provided the opportunity to witness quality control sampling and testing.

All quality control test results shall be documented by the Contractor as required by Section 100-08.

100-08 DOCUMENTATION

The Contractor shall maintain current quality control records of all inspections and tests performed. These records shall include factual evidence that the required inspections or tests have been performed, including type and number of inspections or tests involved; results of inspections or tests; nature of defects, deviations, causes for rejection, etc.; proposed remedial action; and corrective actions taken.

These records must cover both conforming and defective or deficient features, and must include a statement that all supplies and materials incorporated in the work are in full compliance with the terms of the contract. Legible copies of these records shall be furnished to the Engineer daily. The records shall cover all work placed subsequent to the previously furnished records and shall be verified and signed by the Contractor's Program Administrator.

Specific Contractor quality control records required for the contract shall include, but are not necessarily limited to, the following records:

a. Daily Inspection Reports. Each Contractor quality control technician shall maintain a daily log of all inspections performed for both Contractor and subcontractor operations on a form acceptable to the Engineer. These technician's daily reports shall provide factual evidence that continuous quality control inspections have been performed and shall, as a minimum, include the following:

1) Technical specification item number and description;
2) Compliance with approved submittals;
3) Proper storage of materials and equipment;
4) Proper operation of all equipment;
5) Adherence to plans and technical specifications;
6) Review of quality control tests; and
7) Safety inspection.

The daily inspection reports shall identify inspections conducted, results of inspections, location and nature of defects found, causes for rejection, and remedial or corrective actions taken or proposed.

The daily inspection reports shall be signed by the responsible quality control technician and the Program Administrator. The Engineer shall be provided at least one copy of each daily inspection report on the work day following the day of record.

b. Daily Test Reports. The Contractor shall be responsible for establishing a system which will record all quality control test results. Daily test reports shall document the following information:

1) Technical specification item number and description;
2) Test designation;
3) Location;
4) Date of test;
5) Control requirements;
6) Test results;
7) Causes for rejection;
8) Recommended remedial actions; and
9) Retests.

Test results from each day's work period shall be submitted to the Engineer prior to the start of the next day's work period. When required by the technical specifications, the Contractor shall maintain statistical quality control charts. The daily test reports shall be signed by the responsible quality control technician and the Program Administrator.

100-09 CORRECTIVE ACTION REQUIREMENTS

The Quality Control Program shall indicate the appropriate action to be taken when a process is deemed, or believed, to be out of control (out of tolerance) and detail what action will be taken to bring the process into control. The requirements for corrective action shall include both general requirements for operation of the Quality Control Program as a whole, and for individual items of work contained in the technical specifications.

The Quality Control Program shall detail how the results of quality control inspections and tests will be used for determining the need for corrective action and shall contain clear sets of rules to gauge when a process is out of control and the type of correction to be taken to regain process control.

When applicable or required by the technical specifications, the Contractor shall establish and utilize statistical quality control charts for individual quality control tests. The requirements for corrective action shall be linked to the control charts.

100-10 SURVEILLANCE BY THE ENGINEER

All items of material and equipment shall be subject to surveillance by the Engineer at the point of production, manufacture or shipment to determine if the Contractor, producer, manufacturer or shipper maintains an adequate quality control system in conformance with the requirements detailed herein and the applicable technical specifications and plans. In addition, all items of materials, equipment and work in place shall be subject to surveillance by the Engineer at the site for the same purpose.

Surveillance by the Engineer does not relieve the Contractor of performing quality control inspections of either on-site or off-site Contractor's or subcontractor's work.

100-11 NONCOMPLIANCE

a. The Engineer will notify the Contractor of any noncompliance with any of the foregoing requirements. The Contractor shall, after receipt of such notice, immediately take corrective action. Any notice, when delivered by the Engineer or his/her authorized representative to the Contractor or his/her authorized representative at the site of the work, shall be considered sufficient notice.

b. In cases where quality control activities do not comply with either the Contractor's Quality Control Program or the contract provisions, or where the Contractor fails to properly operate and maintain an effective Quality Control Program, as determined by the Engineer, the Engineer may:

1) Order the Contractor to replace ineffective or unqualified quality control personnel or subcontractors.
2) Order the Contractor to stop operations until appropriate corrective action is taken.

APPENDIX D

Wisconsin Warranty Program

WISCONSIN PAVEMENT DISTRESS INDICATORS, THRESHOLDS AND REMEDIAL ACTION (Dated 12/11/96)
For Asphaltic Pavements Over Granular Base

Distress Type	Threshold Levels	Remedial Action
Alligator Cracking**	1% of the area in a segment	Remove and replace distressed layer(s). The removal area shall be equal to 150% of the distressed surface to a depth not to exceed the warranted pavement.
Block Cracking	1% of the area in a segment	Remove and replace distressed layer(s). The removal area shall be equal to 110% of the distressed surface to a depth not to exceed the warranted pavement.
Edge Raveling	10% of the segment length	Remove and replace distressed layer(s). The removal area shall be equal to 110% of the distressed surface.
Flushing	20% of the segment length	Remove and replace distressed surface mixture full depth.
Longitudinal Cracking (shoulder line cracking is excluded from the segment measurements)	1000 linear feet for cracks which average greater than ½" 1000 linear feet with 25% of the linear feet having band cracking or dislodgement	Rout and seal all cracks with rubber crack filling material, or agreed upon equal. If over 1000 feet, remove pavement and replace for the effected depth. If under 1000 feet, a patch 2 feet in width and 2 feet longer than the crack length, will be placed for the effected depth or agreed upon equal.
Longitudinal Distortion	1% of the segment length	Remove and replace distressed layer(s). The removal area shall be equal to 110% of the distressed surface to a depth not to exceed the warranted pavement
Rutting*	0.25 inches 0.5 inches	Remove ruts by milling surface with fine-tooth mill, overlaying or micro surfacing Remove and replace surface layer.
Surface Raveling	Rating of none: (for segregation, a none rating is less than three segregated areas per segment. A segregated area is 30 square feet or more in size).	Apply a chip seal coat or partial depth repair.
Transverse Cracking	25 cracks per segment which average greater than ½ inch. 25 cracks per segment with 25% of the linear feet of cracking having band cracking or dislodgement.	Rout and seal all cracks with a rubberized crack filler, or approved equal. Remove and replace distressed layer(s) to a depth not to exceed the warranted pavement.
Transverse Distortion	1% of the segment length	Remove and replace distressed layer(s). The removal area shall be equal to 110% of the distressed surface to a depth not to exceed the warranted pavement.
Patching**	150 linear feet of patching per segment (excluding longitudinal cracking remedial action).	Remove and replace the surface layer or place a minimum 1-¼" overlay.
Potholes, slippage areas, and other disintegrated areas	Existence	Remove and replace the distressed area(s). The removal area will be equal to 150% of the distressed area to a depth not to exceed the warranted pavement.

*The rutting threshold level is waived when the accumulated ESAL's are 50% above the projected fifth year accumulated ESAL's. The contractor will only be responsible for mixture and placement problems.
**The contractor will be relieved of the responsibility for remedial action for Alligator Cracking if the pavement in the area in question is of proper thickness (not thinner than 0.5 inches from plan thickness) and the asphalt cement is of acceptable penetration (average recovered penetration of the surface course is above 30) and one (or more) of the following are true: the base is at least 2.0 inches thinner than plan thickness, or the subgrade density is less than 90% of optimum, or the actual ESAL's are 50% above the projected fifth year accumulated ESAL's.

Extracted Notes: Nominal one mile sections. A one-tenth mile segment in each mile will be evaluated for pavement distress. The segment evaluated will be from 0.3 to 0.4 miles from the start of the section. In addition, in each section, a random one-tenth mile segment will be surveyed. The random one-tenth mile segments will be determined by the Department Each Year. Surveys conducted between April 15 and May 15. If, anything during the warranty period, 30% or more of the project segments require or have received remedial action, then the entire project will receive a remedial action as determined by the contractor or the engineer.

APPENDIX E

AASHTO Accreditation

State Accreditation AASHTO Laboratory Accreditation Program, October 1997

State	Asphalt Cement	Hot-Mix Asphalt	Emulsified Asphalt	Hot-Mix Asphalt Aggregate	Soil	Portland Cement Concrete	Portland Cement Concrete Aggregate	Hydraulic Cement
Alabama	✓	✓	✓	✓	✓	✓	✓	
Alaska	✓	✓	✓	✓	✓	✓	✓	
Arizona	✓	✓	✓	✓	✓	✓	✓	
Arkansas	✓	✓	✓	✓	✓	✓	✓	✓
California	✓	✓						
Colorado	✓	✓	✓	✓	✓	✓	✓	
Connecticut	✓	✓	✓	✓	✓	✓	✓	✓
Delaware	✓	✓		✓	✓		✓	
Florida (a)	✓	✓	✓	✓	✓	✓	✓	
Georgia	✓	✓	✓	✓	✓	✓	✓	✓
Hawaii	✓	✓	✓					
Illinois	✓	✓	✓	✓	✓	✓	✓	✓
Indiana	✓	✓	✓	✓	✓	✓	✓	✓
Iowa	✓	✓	✓	✓	✓	✓	✓	
Kansas	✓	✓	✓	✓	✓	✓	✓	
Kentucky	✓	✓	✓	✓	✓	✓	✓	✓
Louisiana	✓	✓	✓	✓	✓	✓	✓	✓
Maine	✓	✓	✓	✓	✓	✓	✓	✓
Maryland	✓	✓	✓	✓	✓	✓	✓	
Massachusetts	✓	✓	✓	✓	✓		✓	
Michigan	✓			✓		✓	✓	✓
Mississippi	✓	✓	✓	✓	✓	✓	✓	
Missouri	✓	✓	✓	✓	✓	✓	✓	✓
Montana	✓	✓	✓	✓	✓		✓	
Nebraska	✓	✓	✓	✓	✓	✓	✓	✓
Nevada	✓	✓	✓	✓	✓	✓	✓	
New Jersey	✓	✓	✓	✓	✓	✓	✓	
New Mexico	✓	✓	✓	✓	✓	✓	✓	
New York	✓	✓	✓	✓	✓	✓	✓	✓
North Carolina	✓	✓	✓	✓	✓	✓	✓	
North Dakota	✓	✓	✓	✓	✓		✓	
Ohio	✓	✓	✓		✓			
Oklahoma	✓	✓	✓	✓	✓	✓	✓	
Oregon	✓	✓	✓	✓	✓	✓	✓	
Pennsylvania				✓	✓	✓	✓	
Rhode Island	✓	✓	✓	✓	✓	✓	✓	
South Carolina	✓	✓	✓	✓	✓	✓	✓	✓
South Dakota	✓	✓	✓	✓	✓	✓	✓	
Tennessee	✓	✓	✓	✓	✓	✓	✓	
Texas	✓	✓	✓	✓	✓	✓	✓	
Utah	✓	✓	✓	✓	✓	✓	✓	
Vermont				✓	✓	✓	✓	
Virginia	✓	✓	✓	✓	✓	✓	✓	✓
Washington	✓	✓	✓	✓	✓	✓	✓	✓
West Virginia	✓	✓	✓	✓	✓	✓	✓	
Wyoming	✓	✓	✓	✓	✓	✓	✓	✓

(From www.aashto.org)

The AASHTO Accreditation Program

For a complete listing of accredited laboratories, please click here.

The AAP utilizes laboratory inspection and proficiency sample services provided by the AASHTO Materials Reference Laboratory (AMRL) and the Cement and Concrete Reference Laboratory (CCRL). AMRL and CCRL are Research Associate programs located at the Building and Fire Research Laboratory of the National Institute of Standards and Technology (NIST).

Initial Accreditation—For initial accreditation a laboratory must satisfy the quality system requirements specified in AASHTO Practice R18 and receive an on-site inspection(s) from AMRL and/or CCRL for test methods for which accreditation is being sought. The laboratory must then provide AMRL with satisfactory evidence that all deficiencies noted during the on-site inspection(s) were corrected. In addition, the laboratory must be enrolled in applicable AMRL and CCRL proficiency sample programs and provide AMRL with documents, forms and records which indicate that it has established a quality system that meets AAP Criteria. When accreditation is granted by AASHTO, accreditation certificates are issued to the laboratory and the laboratory is entered into the AAP Directory of Accredited Laboratories which is issued quarterly. Separate certificates of accreditation are issued for the fields of testing covered in ASTM Standard Practice C1077, C1222, D3666, and D3740. Each certificate includes the name and location of the laboratory, the scope of the accreditation including field of testing and specific test methods, and the certificate's issuance and expiration dates. (The scope of a laboratory's accreditation is limited to the test methods covered during its most recent on-site inspection(s).)

Maintaining Accredited Status—In order for an accredited laboratory to maintain accredited status the laboratory must receive applicable routine AMRL and CCRL on-site inspections and provide AMRL with satisfactory evidence that all apparatus, procedural or quality system deficiencies noted during the on-site inspection were corrected. In addition the laboratory must test applicable proficiency samples and provide AMRL with an explanation of the steps taken to attempt to determine the cause of results beyond two standard deviations of the grand average values.

Accreditation Decisions—AASHTO uses a management council approach in reaching accreditation decisions and considers a laboratory's accreditation status at three established times during the ongoing accreditation process: (1) prior to the issuance of the initial accreditation certificate, (2) every twelve months after the initial accreditation decision, and (3) after each on-site inspection. AAP includes a two level appeal process which permits a laboratory to obtain further consideration if it disagrees with original accreditation decisions.

Limitations of Accreditation—AASHTO accreditation is not intended to imply that an individual or a laboratory has the capability of rendering engineering judgements as to whether the materials covered by the accreditation or as to how the materials covered by the accreditation are to be used in a specific application. An accredited laboratory may publicize its accredited status in reports, stationary, and in business and trade publications with the restriction that the advertising accurately reflects the scope of the laboratory's accreditation and does not imply product certification.

Fees—The cost of AASHTO accreditation includes fees charged by AMRL and CCRL for on-site inspection services and proficiency test samples and a $450 annual administrative fee.

Click here to receive additional information or contact:

AASHTO Material Reference Laboratory
National Instituite of Standards and Technology
Building 226, Room A365
Gaithersburg, MD 20899

Phone: (301) 975–6704
Fax: (301) 330–1956

APPENDIX F

Sample of Utah Qualified Products List

TABLE OF CONTENTS

	SECTION	PAGE
I.	ADHESIVES AND EPOXIES	1
	• Anchoring Epoxies	1–2
	• Bonding and Primer Epoxies	2–3
	• Repair Epoxies	3
II.	AGGREGATES	4
III.	BARRIERS AND ROADSIDE STRUCTURES	4
IV.	BITUMINOUS MATERIALS AND ADDITIVES	4–5
V.	BITUMINOUS REJUVENATORS AND ADDITIVES	5–6
VI.	CULVERTS AND DRAINAGE	6
VII.	DEICING CHEMICALS	7
VIII.	JOINT SEALERS AND FILLERS	7
IX.	MULCH AND EROSION CONTROL	8–9
X.	CONCRETE REPAIR PATCHING MATERIALS	9–12
	• Horizontal	9–12
	• Vertical and Overhead	11–12
XI.	PCC ADMIXTURES	12–13
	• Air Entraining	12
	• Chemical Admixtures	12
	• Mineral Admixtures	13
	• Other	13
XII.	PCC CURING COMPOUNDS	13–14
XXIV.	CHANGES AND ADDITIONS TO THE QPL	25–29
XXV.	NEW PRODUCT TEST SITES	30

P.E. NO.	PRODUCT	COMPANY	STATUS DATE	STATUS	SPECIFICATIONS
88-074	Resinmortar Cart.	Emhart Ind.	11-29-88	Approved	Ressearch Performance Test
92-147	Sikadur 32 Adhesive	Sika Chemical Corp.	07-12-92	Approved	AASHTO M-235/ASTM C881-90
92-149	Sikadur Injection Gel	Sika Chemical Corp.	07-12-92	Approved	AASHTO M-235/ASTM C881-90
92-007	Structural Adhesive	Tremcrete Systems	02-19-92	Approved	AASHTO M-235/ASTM C881-90
93-003	Interplast	Intermark Corp.	01-12-93	Pending	- Testing_

BONDING AND PRIMER EPOXIES

These epoxies are used to bond cementious materials together or as a prime coat applied to the substrate of materials to be bonded.

P.E. NO.	PRODUCT	COMPANY	STATUS DATE	STATUS	SPECIFICATIONS
95-071	Concressive LVI-Std.	Master Builders	08-16-95	Approved	AASHTO M-235/ASTM C881-90
93-015	Euco M-235	Euclid Chemical	01-12-93	Approved	AASHTO M-235/ASTM C881-90
93-018	Euco # 452	Euclid Chemical	01-12-93	Approved	AASHTO M-235/ASTM C881-90
91-037	Evapox Cold Cure # 4	E-Poxy Ind.	12-02-91	Approved	AASHTO M-235/ASTM C881-90
91-042	Evapox Bonding # 1	E-Poxy Ind.	12-02-01	Approved	AASHTO M-235/ASTM C881-90
91-107	Monocryl 100	United Coatings	04-03-92	Approved	AASHTO M-235/ASTM C881-90
89-030	Nitobond Epoxy	Fosroc-Preco	04-05-89	Approved	Research Dept. Performance Test
92-154	Nibobond RWC	Fosroc-Preco	07-12-92	Approved	AASHTO M-235/ASTM C881-90
92-139	Pavement Marker Adhesive	Crafco, Inc.	07-09-92	Approved	Research Dept. Performance Test
92-173	Powergrip Adhesive	Powercrete Div. STO	07-16-92	Approved	AASHTO M-235/ASTM C881-90
91-034	Probond 811 C	Prokrete Ind.	12-02-91	Approved	AASHTO M-235/ASTM C881-90
91-033	Probond 812 C	Prokrete Ind.	12-02-91	Approved	AASHTO M-235/ASTM C881-90
91-035	Probond 813 C	Prokrete Ind.	12-02-91	Approved	AASHTO M-235/ASTM C881-90
92-185	Pro-Poxy 50 LV	Unitex	05-27-92	Approved	AASHTO M-235/ASTM C881-90
92-131	Pro-Poxy 100	Unitex	05-27-92	Approved	AASHTO M-235/ASTM C881-90
92-129	Propoxy 200	Unitex	05-27-92	Approved	AASHTO M-235/ASTM C881-90
92-151	Sika Armatee	Sika Chemical Corp.	07-12-92	Approved	AASHTO M-235/ASTM C881-90
92-148	Sikadur Adhesive 31	Sika Chemical Corp.	07-12-92	Approved	AASHTO M-235/ASTM C881-90
	Sikadur Adhesive 35	Sika Chemical Corp.	07-12-92	Approved	AASHTO M-235/ASTM C881-90
88-046	Sprayable Adhesive	Tremecrete Systems	07-05-88	Approved	Research Dept. PerformanceTest